COSTING ORGANIZATION FOR ENGINEERS

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REFERENCE

COSTING ORGANIZATION FOR ENGINEERS

THE photograph which appears on page 37 of this book illustrates a machine marketed by the National Time Recorder Co, Ltd, and not a Gledhill-Brook machine, as stated

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REFERENCE

FOREWORD

ACCURACY of measurement is one of the foundation stones upon which modern engineering practice is built Whitworth, for instance, inaugurated a system of fine measurement for engineers which became one of the most important means of facilitating the production of repetition parts and eventually the manufacture in mass on a large scale where a great number of specialized operations are involved, and where the need arises for the extensive interchangeability of parts Unfortunately, however, this demand for fine accuracy of measurement, which is an inherent characteristic of the modern engineer in all work relating to materials and manufacturing operations, has not until recently been carried to its logical conclusion and applied to other branches of his work A notable instance is the determination of costs of production where rule of thumb methods largely obtain, and where even to-day simple empirical formulae are employed by some manufacturing engineers who have not made themselves familiar with the basic principles underlying correct costing methods

During recent years, however, much attention has been devoted to the problem of accurate costing in engineering factories, and this interest has been aroused, in no small measure, as a result of war-time conditions The manufacture in various factories all over the country of huge quantities of munitions naturally led to a variety of methods of manufacture of the same article, with consequently varying costs Investigations of these variations led to the development and installation in many cases of efficient costing methods, and brought to the serious attention of many manufacturers, for the first time, the value of accurate Cost Accounting.

But frequently in the past manufacturers have regarded the Cost Accountant as one who appears on the scene after some wasteful expenditure has been incurred, and explains the course that might have been adopted to avoid such waste. Such post-mortem examination, as it were, has now, however, given place to the treatment of the living patient and the diagnosis of the cause of trouble in time to effect a cure The value of such constructive work in engineering factories can only be fully realized in so far as the manufacturing engineer understands methods of costing sufficiently to enable him to interpret results intelligently It is mainly for this reason that the present volume has been written

Some evidence of the manner in which Cost Accountants have advanced the technique of their work is afforded by the establishment and rapid growth of their Technical Association—the Institute of Cost and Works Accountants—and the importance which this Institute attaches to the practical engineering training of persons who apply for membership

In some of the largest works in this country university graduates in engineering, on the completion of their practical training in works, have entered works accounting departments and are employed on responsible costing work. Further, in such works it is recognized by those responsible for the training of young men in all branches of engineering that some instruction in the fundamental principles of Works Costing is essential, and it is not uncommon for such students to have lectures during their training period in Cost Accounting and to spend some of their training period in the Works Accounting Department. It is by such close relationship between the Engineer and the Works Accountant—which thus results in an intelligent appreciation of each other's work—that a degree of accuracy can be ensured in arriving at the cost of production such as is found in every other branch of engineering work.

The importance of accurate knowledge of costs in engineering manufacture should need no emphasis, and the study of the fundamental principles such as are dealt with in this book can be cordially recommended to every young man engaged in engineering manufacture

A P M FLEMING

TRAFFORD PARK,
February, 1923

OCT 1933

PREFACE

THIS book is written for the use of engineers and also for engineering apprentices and students who are coming into contact with the highly complicated organization of a modern engineering works for the first time, and who want to obtain some knowledge of the whole system in which they have a place It contains a straightforward history of what happens to an order for the manufacture of engineering goods, and of how, on completion of the work, the cost of an order is found It is assumed that the work is being done in a typical engineering firm whose manufactures of electrical and mechanical apparatus provide employment for from 5,000 to 10,000 hands The subject is one of which *every* engineer should have a knowledge, but it is one which is only just beginning to be recognized by the leading engineering colleges. The purpose of this book is to provide sufficient information, and yet not such an amount as will debar it a place in the already crowded syllabus of a present-day engineering course. To a few it may indicate that there is a big field in Cost Accountancy for the man who is trained as a sound theoretical and practical engineer, and who possesses first-class qualifications in the two professions For all, it is hoped, it will engender an interest in the organizing work which controls and then presents the results of the various activities in the engineering shops

I have to acknowledge the courtesy of the Editors of *Business Organisation* and *Engineering and Industrial Management* in permitting the use of portions of previously published articles. I am also indebted to Messrs The British Tabulating Co, Ltd, The Gledhill-Brook Time Recorders, Ltd, and The Hayward Co, for permission to use various photographs appearing in the text Above all, I am indebted to Mr F C. Lawrence, M C., B Sc Tech , A C W.A , for suggestions and criticisms which have, I believe, added materially to the usefulness of the whole book. The guiding motive with us both has been to present Works Accountancy in such a manner that more interest will be taken in this subject by the engineer, and our object will have been more than fulfilled if this book should influence some of the younger engineers to take up this absorbing profession and link it with their own.

E. W. W.

KNUTSFORD,
February, 1923

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COSTING ORGANIZATION FOR ENGINEERS

CHAPTER I

INTRODUCTORY

As a rough average it may be stated that only about half the standard selling price of an electrical motor or steam turbine covers expenditure on raw material and wages of employees directly engaged on machining or fitting the machine under consideration The balance covers, in addition to the profit, a great variety of direct and indirect expenses, the nature of which are discussed in later chapters The price thus consists partly of the principal direct charges and partly of miscellaneous indirect expenses and profit

The organization of a large modern Works can be divided up into much the same divisions On the one hand, there are the activities for which the firm exists—the Shops which actually make the products sold, and the engineers who design and control the form which those products shall take. On the other hand, there are all the subsidiary activities which are equally essential to the life of the Works, and without which no manufacturing concern could exist. These subsidiary activities include the buying, transport and storage of the raw material, the organization of the labour in the Shops, maintenance work, the storage of the finished product, the Sales organization, the keeping of the financial accounts, the obtaining of the figures representing what it has cost to make the products, and a whole variety of other lesser, but still important, activities These two main divisions of a Works are absolutely dependent on each other; the Shops cannot keep running without the controlling organization, and these other departments only exist in order to be of use to the Shops. It is equally essential that there shall be no "water-tight compartments" within either of these main divisions, so that all the different sections of a factory shall work harmoniously together. The Cost Department usually forms the connecting link between the Shops and the Offices, and it is therefore, an especial necessity that there should be a good relationship between the Cost Department and the Shops. All cost and statistical records are primarily based on information given in the Shops, and hence it is obvious that in order to obtain accurate results the Shop records must be accurately kept Accurate Shop records will only be kept if the engineering and works staffs fully realize the importance of the information which they are recording, and if they have a live interest in what is being done with the figures which they pass on. When a member of the office staff is making an enquiry on some point in the Shops, he is too often met with the reply, "I cannot be bothered with that; my work is to get things *made*, not to juggle with figures." Happily this point of view is rapidly growing less as the mutual understanding of each other's work and problems increases. Frequently the Cost Department could give assistance to the engineers if only the engineers understood sufficient of the working of the Cost Department to be able to know when to ask for information and assistance It is easy for the Shops staff to take a keen interest in the work of the Cost Department because it is in touch with their own work all the time In addition, costing is live, interesting work, full of fresh problems touching many different subjects, and out of which the old-fashioned drudgery of office routine has been largely eliminated by up-to-date office machinery and modern efficient methods of handling such as the ones which are exemplified in later chapters.

The system described in this book is to a large degree a summary of the essential features of the organizations of some of the largest manufacturing concerns in this country. The account may not exactly fit any other Engineering Works, but a clear understanding of the organization of any one Works will make the organization of any other Works very much more easy to comprehend The Works to which the organization described applies has been assumed to consist of the following main departments—

SHOPS

- (a) *Mechanical Manufactures*
    - (1) Turbines, Steam and Gas Engines
    - (2) Condensers, Pumps, Gear-wheels, etc.
- (b) *Electrical Manufactures*
    - (1) Electrical Motors and Generators
    - (2) Electrical Transformers
    - (3) Electrical Switchgear
    - (4) Electrical Meters and Instruments
- (c) *Subsidiary or " Feeder " Departments*
    - (1) Iron Foundry
    - (2) Brass Foundry
    - (3) Forge
    - (4) Pattern Shop
    - (5) Joiners' Shop
    - (6) Tinsmiths, Painters, etc.
    - (7) Electrical Coils (for motors, transformers, etc)
    - (8) Testing, Chemical, and Research
    - (9) Work's Power Supply.
    - (10) Maintenance, Cranes, etc
- (d) *Outside Erection Departments*

OFFICES.

- (1) Sales (including Tendering and Order Depts.).
- (2) Production and Specification Depts.
- (3) Stores and Buying Depts.

(4) Engineering and Draughting Depts. (including Blue Printing Section).
(5) Shipping Dept.
(6) Cost Dept.
(7) Cashier's Dept
(8) Financial Dept.

This list covers the main departments which are likely to be met with, but the list will be different for every different Works Some of the smaller departments have been intentionally omitted from the list in order not to confuse the issue In later pages each department is described in the natural sequence in which it affects a typical order passing through the Works

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CHAPTER II

THE ESSENTIALS OF COSTING

THE terminology used in costing is still very far from standard. It may therefore be advantageous, before proceeding further, to indicate the meaning of the different terms as used in this book, and at the same time to summarize the main principles of engineering costing.

The different components which go to make up the selling price of a finished product are explained below, and can be tabulated as follows—

Direct Material	Direct Expense	Factory Cost	Total Cost	Selling Price
Direct Labour				
Factory Overhead				
Office Oncost				
Profit				

The term "Material" is usually taken to include both raw material and finished or semi-finished products which are bought from outside. Thus, if a steel casting for a steam-chest had been bought from an outside manufacturer, the whole cost of the casting as supplied would be treated as "Material" in spite of the fact that this figure includes within itself, as regards the supplier, all the components of selling price that are indicated in the table given above.

The term "Direct Labour" includes all the wage outlay that has been expended directly in machining, fitting, overhauling or testing the article made.

The "Factory Cost" consists of these direct material and labour charges together with a third component termed in this book "Factory Overhead Expense." A typical list of the items which are included in the term "Factory Overhead Expense" is given on page 6. The chief difficulty of Cost Accounting lies in the apportionment and distribution of this third component which usually forms an even bigger proportion of the total Factory Cost than the whole of the direct labour charges. The manner in which this Factory Overhead is applied is thus of the very greatest interest to the engineer, as very often it is the value of these charges which will determine whether it is profitable to continue the manufacture of some particular line of goods.

To sell an article at the Factory Cost, however, would entail an actual loss on the order, as a further increase in the price must be made to cover administrative, selling, and other general expenses connected chiefly with the offices. A typical list of the items which are included in the term "Office Oncost" is given below, alongside the list of items which make up "Factory Overhead."

The standard selling price is formed by adding a percentage to the total cost to cover the profit which it is desired to make It should be particularly observed that the selling price is quite independent of the total cost as the profit factor is a perfectly arbitrary one. The selling price will vary to a large extent in accordance with market conditions at the time of sale, and in exceptional conditions may even be below actual cost.

Factory Overhead Expenses

1. Rent, rates, taxes, and insurance (health, accident, and fire)
2. Motive power, transport, fuel, gas, water, lighting and heating
3. Patent fees and royalties
4. Non-productive wages of storekeepers, firemen, enginemen, time-keepers, cost clerks, factory clerks, superintendents, managers, and engineering staff
5. Repairs, renewals and depreciation of plant, machinery, cranes, tools, land and buildings
6. Factory printing, stationery, etc.

Office Oncost Expenses

1. Rent, rates, taxes, and fire insurance of offices, warehouse, showrooms, etc
2. Water, lighting, and heating of offices, warehouse, showrooms, etc
3. Bad debts, discounts, etc
4. Salaries of travellers and of the Financial Department staff, directors' fees
5. Depreciation of furniture, fixtures, and fittings
6. Carriage outwards, packing materials, printing, stationery, postage, advertising, etc.
7. Interest on capital, loans and debentures, bank interest

In comparing the above lists of items making up Factory Overhead Expenses and Office Oncost Expenses, it should be noted that several items such as "rent," "water," and "printing" may appear under both classifications

Office oncost and profit are factors over which the engineer and cost accountant can rarely exercise any control. They amount usually to an extra of from 10 per cent to 25 per cent each of the Factory Cost. In this book they are not taken into consideration, and the basis of the description is taken as the Factory Cost made up of material, labour, and factory overhead charges.

The following table illustrates the proportions of the different components of Factory Cost for different classes of engineering products. It should be noted that in this table and throughout the book the whole cost of rough castings is included under the heading "Material." The figures given under the headings "Labour" and "Overhead" include the work done in subsidiary departments. Thus in the case of Turbines and Motors, 50 per cent of the Factory Cost consists of charges for raw material, rough castings and small fittings purchased outside, 25

	Direct Material	Direct Labour	Shop, and Office Staff Labour in Overhead	Remainder of Factory Overhead
Main Departments—	%	%	%	%
Turbines, Steam and Gas Engines, Electrical Motors and Generators	50	25	15	10
Electrical Switchgear, etc	35	30	23	12
Subsidiary Departments—				
Iron Foundry	40	28	20	12
Forge .	50	20	12	18
Pattern Shop .	20	50	15	15
Tinsmiths .	40	42	10	8
Electrical Coils .	70	17	8	5
Average over whole Works .	50	25	15	10

per cent consists of direct machining and fitting charges, and the balance of 25 per cent consists of charges for Factory Overhead.

The figures are only given as a general example, as, of course, any alterations in the organization or in the proportion of small parts purchased from outside suppliers will at once affect the relative proportions. It will be noticed that the turbines, steam and gas engines, electrical motors and generators are grouped together, the composition of their Factory Costs being the same. With the smaller work, such as switchgear, the value of the material forms a much smaller proportion of the whole, and the value of the labour component is correspondingly increased The figures given under the heading, " Remainder of Factory Overhead" chiefly represent power supplies together with annual charges, such as rent and depreciation The departure of electrical switchgear from the average charge of 10 per cent for these expenses is largely accounted for by the difference in value per unit of area occupied in the Works by this class of apparatus. Switchgear has a low cost per unit of manufacturing area required

The figures given for the subsidiary departments also show some interesting variations. The high proportions of overhead in some departments are explained by the large amount of floor space required by the iron foundry, the big charges to the forge for fuel and draught, and the high rate of depreciation incurred by the pattern shop stores In the electrical coils department the cost of material forms a large proportion of the whole cost due to high unit cost, and the Factory Overhead is correspondingly light, there being a large output per unit of floor-space in this department

At this point it will be advisable to show the difference between the two chief types of engineering costs, and to illustrate the meaning and composition of the " Work in Progress Statement."

The manufacture of such products as turbines, motors and transformers is usually costed by means of a "Job Cost," i.e. all direct material and labour is charged to individual "job numbers" in the shops. A job number may, of course, represent only one machine in the Turbine Department, whereas in the Meter Department it might represent a thousand watt-hour meters being made to fill one order.

A type of costs less frequently used in Engineering Works is the system of "Process Costs" In this system all charges are made to a general process number, and the product is then charged out at so much per unit. For instance, in a department dipping electrical coils in insulating varnish it would obviously be impossible to charge the cost of the labour and of the varnish used to each set of coils What is actually done is to find the cost of material, labour and factory overhead absorbed for a definite weight of product, and thus to calculate the amount per unit weight which should be charged A system of Process Costs might be used in a department making punchings of electrical sheet steel for the armatures and poles of motors, and some modification of the system is usually found in connection with Foundry Costs

A Work in Progress Statement is a financial account which is of great interest to the engineer, as it will always give him a very good indication of the state of work in the Shops. In order to get a clear understanding of the working of this statement it is as well to think of it as of a person who is responsible for all the work of the department. Any material given to him or work done for him will be charged (or debited) to him. On the other side of the account he will be given credit for all the finished work he turns out, and for which he is no longer responsible The balance of the account, or difference between the total debits and credits at any time, will thus always indicate the total value in the Shops of the unfinished work and stocks on hand at that date. Below is given a typical departmental Work in Progress Statement for one month.

WORK IN PROGRESS STATEMENT

"X" DEPT JULY, 192.

Debit (Input)	£	*Credit (Output)*	£
Balance of account brought forward from June	17,650	Finished material shipped to Warehouse during July	3,660
Wages paid during July	480	Material shipped to other depts during July	130
Factory Overhead Expenses charged during July	540	Work done during July on tools, buildings, etc, not chargeable to customers' orders	90
Material and finished parts received from other depts during July	1,270	Balance of account carried forward to Aug	18,490
Material purchased from other firms during July	2,430		
£	22,370	£	22,370

This account shows that the total value of the raw material actually in "X" Department, plus the expenses incurred to date in making this raw material into the finished product were £17,650 and £18,490 at the beginning and end of July respectively These figures would include the value of the departmental stores of raw material at each date.

It will be seen that the Work in Progress Statement automatically forms a summarized monthly inventory of all the work being done in "X" Department. Once a year the balance of the account would be checked by an actual stocktaking of all the work and stocks of material which are tangibly present in the Shops.

The value of this account is very evident on a little consideration. The increase of £840 in the balance which occurred during July indicates either very heavy purchases of raw material for the month or a low tonnage of finished products shipped to the warehouse. The former reason might be due to material being bought before it was required for working on in the Shops, the latter reason might be due to an imperfect production programme whereby nearly finished products were not completed and despatched to the warehouse. Whatever the cause of the increase is eventually found to be, a very important function will have been performed by the Work in Progress Statement drawing attention to the change The whole of the £18,490 balance represents money sunk in the business for which interest is being paid, and for which no return is being received It will thus be seen that it is most important to keep this figure down as low as is practicable In the realization of this object the greatest assistance will be given to the engineer by a careful monthly comparison of the figures making up the departmental Work in Progress Statements. In any firm where the costing system forms the basis of the financial system and where the Costing and Financial Accounts are properly interlocked, the Work in Progress Statement will certainly assume a very important position

CHAPTER III

HOW A CUSTOMER'S ORDER IS DEALT WITH

ASSUMING that the Selling Department have got into touch with " Power Supply Co ," a probable customer, and that a tender has been made stating the lowest price for which " The General Engineering Works " is prepared to manufacture, we will take up the history of the order for the manufacture of a complete set of plant for a generating station at the point where the order is definitely placed with " The General Engineering Works "

All previous correspondence with " Power Supply Co " will be handed over by the Selling Department to the Order Department, and henceforth the Order Department will be responsible for keeping the Works in touch with the requirements of the customer and for the general control of the order

For the sake of example, let us assume that the order covers the plant tabulated on page 13.

It should be observed that the money values given in this example under the heading " Expected Factory Cost " are purely arbitrary ones, and are given only for the sake of illustration A good idea of the complexity of the problems arising in such an order may be obtained by examining the photograph given in Fig 1 on page 14 This photograph shows the detail of construction required in the 690 B H P., 1900 R.P M steam turbine and oil pumps installed in the Anglo-Persian Oil Company's works.

The order, on receipt, would be given a job number—in this case, "A 188" The order would be divided up into its main parts and given sub-numbers as shown (1–15). This will facilitate the general handling of the order in the different departments of the Works These

PLANT ORDERED BY "POWER SUPPLY CO" FROM "THE GENERAL ENGINEERING WORKS"

DATE OF ORDER 1 1 1923

Job No	No required	DESCRIPTION	Expected Factory Cost		Selling Price[1]
			Each	All	
			£	£	£
A 188/ 1	1	15,000 K W, 3,000 R P M, No 25 Steam Turbine	5,000	5,000	
A 188/ 2	1	15,000 K W, 18,750 K V A, 3-phase, 50 period, 6,600 volt Alternator	10,000	10,000	
A 188/ 3	1	Exciter for 15,000 K W Alternator	500	500	
A 188/ 4	1	Exciter shunt field Rheostat	50	50	
A 188/ 5	1	8 H P Motor for Turbine Governor	10	10	
A 188/ 6	1	Surface Condenser, 25,000 sq ft	4,500	4,500	
A 188/ 7	2	Extraction Pumps for Condenser	200	400	
A 188/ 8	2	25 H P Motors for Extraction Pumps	50	100	
A 188/ 9	2	Starters for Pump Motors	50	100	
A 188/10	1	Circulating Water Pump, bought complete from "Pumps, Ltd"	1,000	1,000	
A 188/11	1	500 H P Motor for Circulating Pump	600	600	
A 188/12	1	Starter for Circulating Pump Motor	80	80	
A 188/13	1	Set of Pipes and Valves	3,000	3,000	
A 188/14	2	1,500 K V A Transformers	1,000	2,000	
A 188/15	1,000	Gallons Oil, shipped direct to "Power Supply, Ltd," by "Oil, Ltd"	1/-	50	
			Totals	£27,390	

Prices quoted are for free delivery at London

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[1] Factory Cost plus Office Oncost Expenses plus Profit

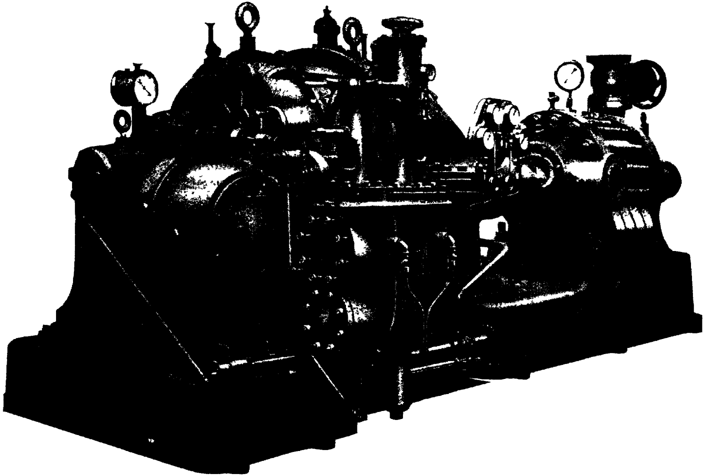

Fig 1—690 B.H P, 1900 R P M. Turbine Driving Oil Pumps

preliminary matters having been arranged, the next step for the Order Department is to inform all other departments concerned of the particulars of the work to be done

In the first place, a price sheet would be sent by the Order Department to the Financial Department. This price sheet would give in addition to the details shown in the statement on page 13, particulars as to terms of the contract and any other matters which specially affect the Financial Department. With this price sheet for guidance, the Financial Department are now enabled to invoice material as and when it is shipped to "Power Supply," and also to collect payment from the customer in accordance with the terms of the contract.

A second copy of the price sheet is sent to the Shipping Department in order that they may have full information about the order when it comes to be dispatched

Although price sheets have been issued to the Financial and Shipping Departments, nothing has yet been done to put the order into work in the Shops In order to achieve this object the Order Department issue a number of "Job Order Sheets." In the case of "Power Supply," fifteen job order sheets would be required—one for each of the items of plant detailed on page 13 These job order sheets would be issued on a departmental basis, e g. the job order sheet for A 188/1, the steam turbine, would only be issued to the Turbine Department, and that for A. 188/2, the alternator, would only be issued to the department dealing with these electrical machines.

Job order sheets form the instructions to the manufacturing departments to commence work on the order The type of information given can be gathered from the example given in Fig. 2 for the turbine under consideration

It will be observed that copies of the job order sheet are sent to the Production Department, Cost Department and Drawing Office. The copy sent to the Production Department will enable the programme of manufacture

JOB ORDER SHEET. Job No *A 188/1*

Issued *1 2 1923* for "*Power Supply*" Delivery due *15 2 1924*

The following plant is to be manufactured on the above Job No

One 15,000 K W, 3,000 R P M, No 25 High-pressure Steam Turbine

This turbine is to be capable of developing full load continuously at the terminals of the 15,000 K W, 18,750 K V A, 3-phase, 50 period, 6,600-volt Alternator ordered on Job No A 188/2, when supplied with steam at a pressure of 200 lbs per sq in, superheated 150° F, and exhausting into the surface condenser ordered on Job No A 188/6[1]

Copies of this sheet sent to *Turbine* Production Dept
Turbine Cost Dept
Turbine Drawing Office

Fig 2—Job Order Sheet

to be arranged in the Shops, and will give up-to-date information as to the amount of work in hand The copy sent to the Cost Department will give authority for charges on Job No A 188/1 to be accepted The copy sent to the Drawing Office will start off the preliminary work on the order

It will be understood, of course, that usually several months will elapse before actual manufacture can be commenced on a big order such as the one under consideration All the details of design will have to be fully worked out or existing designs modified, and engineering drawings must be made of all the parts to be manufactured. It is not within the province of this book to discuss the organization of the Drawing Office and the manner in which machinery is designed We will, therefore, assume that the work of this department has been satisfactorily accomplished, and will follow the order on the next stage of its travels.

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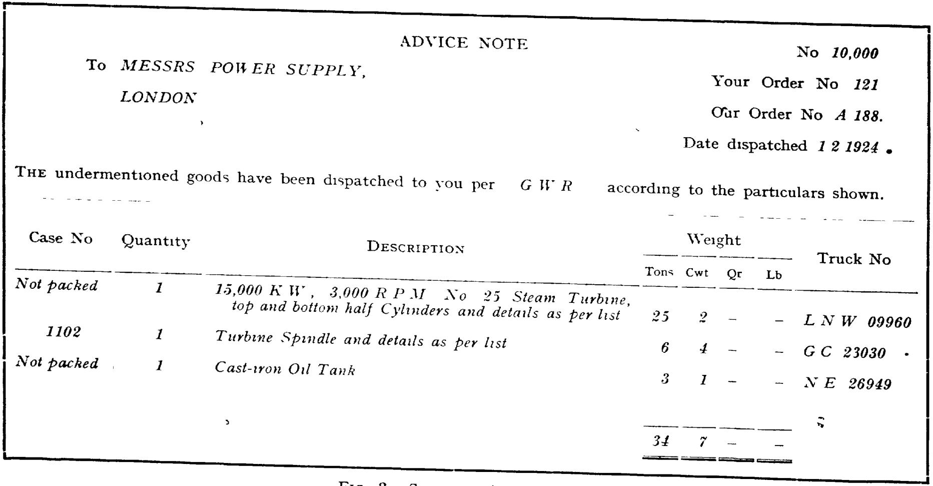
[1] Other particulars as to overload capacity, steam consumption, alternator efficiency, etc, are added

As the plant is designed and drawings made, the Drawing Office give full particulars to the Specification Department. The Specification Department, in conjunction with the Production Department, arrange the details of manufacture in the Shops These two departments henceforth become responsible that the plant is made according to the design and within the time limits laid down in the job order sheet.

It will be clearer if we leave the consideration of the detailed working of these departments and of the Cost Department until a later chapter When ten months or so have elapsed and the completed turbine passes out of the Shops after having successfully negotiated all the elaborate tests and inspections to which a machine of this type is subjected, the section of the Works which becomes responsible for the turbine is the Shipping Department The general Works production programme will have been arranged so that, within a few weeks of the date that the turbine is received, the Shipping Department will be asked also to take charge of all the other plant ordered on the other sub-numbers (A 188/2 to A 188/15) The arrangement of all the details of shipping will call for very careful handling by the department responsible If the order is for export to foreign countries, special attention to the packing will be required Special crates will have to be manufactured, and care exercised in arranging a multitude of details appertaining to crate markings, insurance, customs, ordering of trucks, freight, bills of lading, and general shipping arrangements The large amount of work involved will be apparent when it is mentioned that an order such as the one under consideration may take up to 150 different shipments, ranging from a 50-ton stator, forwarded in a specially constructed railway wagon, down to a few nuts and bolts taken out of the Works by an erecting engineer. Track is kept of all these varying shipments in the following manner. Whenever a shipment



ADVICE NOTE

No *10,000*

To *MESSRS POWER SUPPLY,*
LONDON

Your Order No *121*

Our Order No *A 188.*

Date dispatched *1 2 1924*

THE undermentioned goods have been dispatched to you per *G W R* according to the particulars shown.

Case No	Quantity	DESCRIPTION	Weight				Truck No
			Tons	Cwt	Qr	Lb	
Not packed	*1*	*15,000 K W , 3,000 R P M No 25 Steam Turbine, top and bottom half Cylinders and details as per list*	*25*	*2*	–	–	*L N W 09960*
1102	*1*	*Turbine Spindle and details as per list*	*6*	*4*	–	–	*G C 23030*
Not packed	*1*	*Cast-iron Oil Tank*	*3*	*1*	–	–	*N E 26949*
			34	*7*	–	–	

FIG 3 —SHIPPING ADVICE NOTE

is made from the Works an advice of shipment is invariably made out, as illustrated in Fig 3 Copies of this advice of shipment are sent to (1) the customer—in order that he may know that the goods are on the way, (2) the Order Department—to enable this department to check that the customer's requirements are being fulfilled; (3) the Financial Department—so that application for payment may be made in accordance with the conditions of the contract with the customer for the supply of the goods. A fourth copy of the advice of shipment is filed in the Shipping Department Before the goods are actually shipped these copies are all carefully checked against the price sheet originally issued by the Order Department By this means any discrepancies as to the quantity or description of apparatus to be shipped are discovered before the mistake has gone too far to be rectified

When the apparatus has all been dispatched the order rests in the hands of the Outside Erection Department to carry out the remaining obligations of the manufacturer. The obligations of the purchasers to pay for the goods bought are looked after by the Financial Department. With the completion of the work of these two departments, and in the absence of any special maintenance or insurance terms in the contract, the order may be considered closed In the following chapter we return to the portion of the history that we have omitted, that is, how the plant is manufactured and costed

A summary of the route taken by the order in its travels through the different departments of the Works, so far as has been traced in this chapter, is given on page 20 in the form of a diagram (Fig. 4) The mode of communicating information between each department is shown in italics.

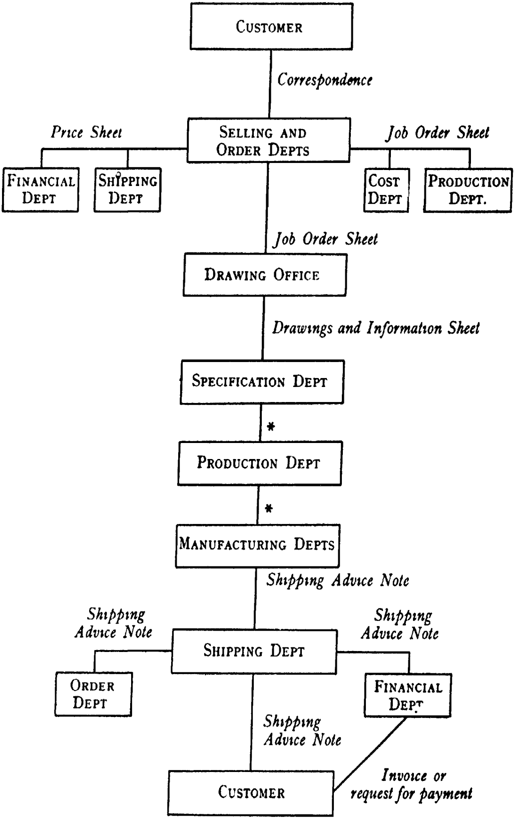


FIG 4 —ROUTE TAKEN BY ORDER IN PASSING THROUGH DIFFERENT DEPARTMENTS OF WORKS ORGANIZATION

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* See Chapter IV and Fig 10 on page 33

CHAPTER IV

MATERIAL

IN the previous chapter the details of the work of the Specification and Production Departments were omitted In this chapter the history is taken up again at the point where the Drawing Office had commenced the design of the plant. The work of the Cost Department only is left for discussion in the succeeding chapters

For the sake of clearness we will follow through the procedure adopted in the making of one portion of the turbine order, and, as our example, will select the general drawing covering the details of the low pressure end of the turbine cylinder being manufactured on Job No. A. 188/1. The cylinder of a turbine consists of the largest castings in the plant, and might be described, roughly, as the steam-tight casing for the working parts of the turbine. In the example under consideration the cylinder consists of a high pressure end and a low pressure end, the latter part comprising a top half casting weighing 4½ tons and a bottom half casting weighing 10 tons, together with three covers and a miscellaneous collection of flanges, studs, bolts, nuts, screws, dowel-pins and eyebolts. For the sake of simplicity the majority of these miscellaneous small parts are omitted from the following description

In the first place, the Drawing Office will prepare a scale drawing of the parts. This drawing will be given a distinctive number—in this case D 4556 In one corner of the sheet there will also be made what is usually called a bill of material, this being an itemized list of all the parts appearing in the drawing, together with a list of the nuts, bolts, etc , required in connection with these parts. Part

Drawing *D 4556* *Low Pressure End of Cylinder* Scale *1″ = 1′ 0″*

Item No	Stock Part No	Quantity	Description	Existing Drawing No	Material	Pattern No
1		*1*	*Cylinder (top half)*	—	*Cast Iron*	*P 473*
2		*1*	*Cylinder (bottom half)*	—	*Cast Iron*	*P 474*
3		*1*	*Cover for centre pedestal*	—	*Cast Iron*	*P 249*
4		*1*	*Cover for cylinder (top half)*	*D 386*	*Cast Iron*	*P 250*
5		*1*	*Cover with lifting boss*	*D 223*	*Cast Iron*	*P 919*
6	*S 1016*	*2*	*Blank Flanges for core holes*	*D 878*	*Cast Iron*	
7		*1*	*Blank Flange for heater belt*	*D 298*	*Cast Iron*	*P 101*
9		*2*	*Special Studs 2″ diam × 7¼″ long for horizontal joint*	*D 457*	*Low Moor Iron*	
10		*14*	*Studs 1¼″ × 5½″ for horizontal joint*		*Mild Steel*	
11	*S 3035*	*2*	*Guide Studs*	*D 462*	*Mild Steel*	
12		*1*	*Eyebolt for cylinder lifting cover, 2¼″ diam × 4″ long*		*Mild Steel*	
20		*56*	*1¼″ semi-finished Hex Nuts*		*Mild Steel*	

FIG 5 —BILL OF MATERIAL

of the bill of material for the drawing of the low pressure end of the cylinder mentioned above is given in Fig. 5.

A few points in this bill of material perhaps require explanation. In the first column each part of the drawing is given a consecutive item number for purposes of reference. If the part mentioned is usually kept in stock, the stores reference number is given in the second column. (*See* items 6 and 11 in Fig 5) In the case of some of the items enumerated drawings may already exist. If this is so, a new drawing of the part will not be made but the item will be mentioned in the bill of material, and the serial number of the existing drawing quoted in the fifth column (*See* items 4–7, 9 and 11 in Fig 5) The pattern number is quoted in the last column in the case of all castings

A tracing will be made of the drawing, and by means of this tracing a number of blue print copies will be produced These blue print copies will be forwarded by the Drawing Office to the Specification Department along with an information sheet. The information sheet merely quotes the serial numbers of drawings used on the job, and gives the customer's name, the job number, and any special instructions with regard to the manufacture This sheet forms the instructions to the Specification Department to proceed with the ordering of the material for the drawings mentioned on the sheet.

On receipt of any new drawing by the Specification Department, a special card is immediately made up from the bill of material shown on the drawing A separate card is made up for each drawing dealt with, and, in addition to all the particulars shown in the bill of material, the completed card states the names of the departments responsible for providing the raw material and for machining and fitting each item The first six columns of Fig 6 illustrate the card as it would be made up for drawing D. 4556 These cards are kept filed in order of drawing number.

SPECIFICATION SHEET For *Power Supply,* Job No *A 188/1*

Issued *1 6 1923* for assembly in *Turbine Erection* Department

Drawing No	Quantity	Description	Deliver to Dept.	From	Item	Date Delivered	Weight	For Use of Cost Dept: Material £	s	d	Labour £	s	d	Overhead £	s.	d
D 4556	*1*	*Cylinder (top half) Cast Iron P 473*	*Turbine Mach*	*Iron Foundry*	*1*											
,,	*1*	*Cylinder (bottom half) Cast Iron P 474*	*Turbine Mach*	*Iron Foundry*	*2*											
,,	*1*	*Cover for Ped Cast Iron P 249*	*Turbine Mach*	*Iron Foundry*	*3*											
,,	*1*	*Cover for Cyl Cast Iron P 250 D 386*	*Turbine Mach*	*Iron Foundry*	*4*											
,,	*1*	*Cover with boss, Cast Iron P 919, D 223*	*Turbine Mach*	*Iron Foundry*	*5*											
,,	*2*	*Blank Flanges, Cast Iron S 1016, D 878*	*Turbine Details*	*Turbine Stores*	*6*											
,,	*2*	*Special Studs, 2" diam × 7¼" L M Iron*	*Turbine Details*	*Forge*	*9*											
,,	*14*	*Studs, 1¼" × 5½" Mild Steel*	*Turbine Details*	*General Stores*	*10*											
,,	*2*	*Guide Studs, S 3035, D 462, Mild Steel*	*Turbine Details*	*Turbine Stores*	*11*											
,,	*1*	*Eyebolt, 2¼" diam × 4" Mild Steel*	*Turbine Details*	*Forge*	*12*	*1 7 23*	*12 lbs*	–	*4*	–	–	*2*	–	–	*3*	*6*
,,	*56*	*1¼" S F Hex Nuts, Mild Steel*	*Turbine Details*	*General Stores*	*20*											

FIG. 6.—SPECIFICATION SHEET.

On receipt of an information sheet containing instructions to manufacture, the Specification Department collects together all the cards bearing drawing numbers mentioned on the sheet, and proceeds to make up a number of specification sheets such as the one shown in Fig 6 A separate sheet is typed for each main drawing number Sufficient copies are made for distribution to each of the departments mentioned in the fifth column, together with extra copies for the use of the Cost and Production Departments

These specification sheets are issued some time in advance of the date when it is desired to commence manufacture. This enables the various foremen to arrange their work to the best advantage, with a knowledge as to what work future requirements will involve

If the supply of some stock article, such as that mentioned in item 11, Fig 6, is running low, a quantity will be re-ordered for the stores, the procedure adopted being exactly the same as that outlined above

Blue-print copies of the drawings are issued as required to the Shops by the Specification Department

On receipt of the specification sheets, the iron foundry and forge will arrange to make the castings and forgings for which they are responsible (as shown in the fifth column of the sheet illustrated in Fig 6)

In the case of a department drawing material from a stores, a requisition for the items required will be made up from the specification sheet. Thus, in the above example turbine details department will make a requisition on turbine detail stores for items 6 and 11, as illustrated in Fig 7.

We have now reached the point in the progress of Job No A. 188/1 where all the material specified on drawing No. D. 4556 has been ordered from the different departments and stores. Raw material required by the iron foundry and forge will, of course, be obtained by these departments from their own raw material stores.

REQUISITION ON STOREROOM

Job No *A 188/1*

Turbine Details Department requires from *Turbine Details* Stores—

Drawing No	Item	Quantity	Description	Material			Labour			Overhead			Total		
				£	s	d	£	s	d	£	s	d	£	s	d
D 4556	*6*	*2*	*Blank Flanges, S 1016, D 878* *Cast Iron*												
D 4556	*11*	*2*	*Guide Studs, S 3035, D 462* *Mild Steel*												
			Totals												

Date *15 6 23*

Approved *B M*

Fig 7 —Requisition on Storeroom

It is not within the province of this book to go into the details of manufacture in the different shops, or to discuss the arrangement and handling of the material in the different stores. The paper transactions in the Stores, so far as they affect the Cost Department, are described at the end of the chapter in connection with the description of the work of the Buying Department The engineer should appreciate, however, that a sound Stores system, ensuring the safe custody and the proper issue of all stores articles, is an essential for the building up of an accurate cost system Without proper stores accommodation and sound stores methods of dealing with receipts and issues, a full measure of success cannot be achieved by the Cost Department.

Each completed casting and forging which is received in the turbine machining or turbine details departments will be accompanied by a delivery note such as the one illustrated in Fig 8 This delivery note will always be written out in duplicate One copy will be signed by a representative of the department receiving the goods and returned to the forge or iron foundry as a receipt The other copy will be forwarded to the Cost Department so that the Work in Progress Account of the forge or iron foundry may be credited with the value of the goods it has shipped, the Work in Progress Account of the department receiving the goods may be charged accordingly, and that the cost of the work may be booked up against the particular job number. The values to be shown under the headings " Material," " Labour " and " Overhead " are inserted by the Cost Section dealing with the forge or iron foundry costs The method of determining these figures is the same as that used by the Turbine Cost Section for determining the cost of the whole order, and is described in this and succeeding chapters

To each piece of material is tied a " Work Tag " which states the job number, drawing number, and any special

DELIVERY NOTE　　　　JOB NO　*A 188/1*

Forge Department delivers to *Turbine Details* Department

Drawing No	Item	Quantity	DESCRIPTION	Material			Labour			Overhead			Total		
				£	s	d	£	s	d	£	s	d	£	s	d
D 4556	*12*	*1*	*Eyebolt, 2¼″ diam 4″ long, Mild Steel, 12 lbs*	–	*4*	–	–	*2*	–	–	*3*	*6*	–	*9*	*6*
			Totals		*4*	–	–	*2*	–	–	*3*	*6*	–	*9*	*6*

Received by　　*A L*

Date　　*1 7 23*

FIG 8—DELIVERY NOTE

instructions which may be required This enables the identity of each piece of material to be preserved.

As each part is worked upon, the employees record the time spent by means of job tickets, such as those described in Chapter V As the parts are finished they are shipped to the erecting department, delivery notes being made out and dealt with in the same manner as that described above. It must not be assumed that the whole procedure outlined above is by any means standard It is only a description of one out of a number of methods which might be used to obtain the required results

Let us now see how the Cost Department deals with the requisitions on storeroom and the delivery notes which are received from time to time as the work in the Shops progresses (*see* Figs 7 and 8) The value of the items shown on these requisitions and delivery notes will have been previously entered up in the columns provided, either by the Storeroom or by the Cost Section of the department shipping the material

On the receipt of the original instructions for commencing manufacture, the Cost Department open a summary of cost for each job number. The form adopted for the summary of cost might be such as the one illustrated in Fig. 9. On to this sheet all charges against the job are posted in totals as received The total cost of a job to date can thus readily be ascertained from the figures shown on the cost summary sheet.

Each week all the material requisitions and delivery notes that have been received in the Turbine Cost Department on any one job number will be collected together and the total value will be posted to the cost summary sheet for that job Thus the summary given in Fig 9 shows that the total charges received on Job No. A. 188/1 for the week ending 16 4.1923 were £23 10s 8d , consisting of a charge of £20 0s. 3d from the Drawing Office and charges from Stores and other departments on requisitions

COST SUMMARY SHEET for *1—No 25 Turbine* JOB NO *A. 188/1*

TURBINE DEPARTMENT

Date Job commenced *1 3 1923*

Date Job completed

Date Week Ending.	Charges from Stores and other Depts as per Requisitions and Delivery Notes									Charges from own Dept as per Job Tickets						Drawing Office Charges, etc			Total Cost		
	Material			Labour			Overhead			Labour			Overhead								
	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d
2 4 23																*18*	*1*	*6*	*18*	*1*	*6*
9 4 23																*21*	*3*	*8*	*21*	*3*	*8*
16 4 23	–	*19*	*4*	*1*	*3*	*4*	*1*	*7*	*9*							*20*	–	*3*	*23*	*10*	*8*
23 4 23	*3*	*16*	*8*	*4*	*2*	*1*	*5*	*1*	*2*	*5*	*3*	*4*	*6*	*6*	*8*				*24*	*9*	*11*
30 4 23	–	*17*	–	–	*15*	*6*	–	*18*	–	*9*	*2*	*6*	*11*	*3*	*2*	*5*	*4*	*8*	*27*	*10*	*10*

FIG 9—SUMMARY OF COST FORM

and delivery notes totalling £1 3s. 4d. for labour, £1 7s. 9d. for Factory Overhead and 19s 4d for raw material The way in which charges from the turbine department are obtained is dealt with in the next chapter.

In addition to this summarized cost it will be found very useful to keep a detailed cost of the parts For this purpose the specification sheets illustrated in Fig. 6 and described on page 25 may be utilized. The individual charges shown on the material requisitions and delivery notes are entered up on the specification sheets against each item. The procedure will be clearly understood by referring to item 12 in the specification sheet given in Fig. 6, which shows the amounts entered up for the forge charge on the delivery note illustrated in Fig. 8. Quick cross-reference is made between the material requisitions, the delivery notes and the specification sheets by means of the drawing numbers which are invariably quoted in the first column of each form. For this purpose the specification sheets on any one job are filed together in order of drawing number.

Any material defective, or returned for any reason, will be allowed for by means of credit notes, which will be entered up on the summary of cost and specification sheets in the same manner as the charge notes, the only difference being that they are entered up in red ink in order to show that the figures must be subtracted from the total cost instead of being added

By means of the detailed posting to the specification sheets a very effective check is obtained at the close of the job, as any over- or under-issues of material can be immediately detected. In addition, any discrepancies in the cost due to missing charges, missing credit notes, double charging or wrong specification will be easily found and rectified The possibility of thus rapidly checking the figures at the close of a job is of very great advantage—as will readily be realized when it is mentioned that a big turbine may consist of over 25,000 separate pieces of material, ranging from a 10 ton cylinder casting down to the three thousand or so little pieces of steel required for riveting the blades to the revolving discs.

A further advantage of this detailed posting of charges to the specification sheets is that whenever a detailed analysis of the cost of a product, the cost of a spare part, or any other such information is required, the specification sheets are immediately available and will provide whatever information is sought.

It is now necessary to detail the procedure adopted by the Buying Department in making purchases of finished parts from outside suppliers

In the first place, any part required from an external manufacturer will be ordered by the Production Department from the Buying Department on a specification sheet or on a special requisition All requisitions for any one type of article will be recorded on a separate card in the Buying Department. On this card will afterwards be recorded all the transactions of the Buying Department in relation to that class of article. Enquiries for the supply of the articles required will be sent out to likely suppliers, prices quoted will be compared, and eventually a contract for the supply will be made When the goods arrive at the Works they will be examined in order to see that they conform with the order, and the invoice will be checked to see that it correctly describes the quantity, quality, and type of the goods actually received. After these things have been done the invoice may be passed for payment and sent to the Financial Department for settlement of the account At the same time a form will be sent to the Production and Cost Departments giving a description of the articles received, together with a note of the price paid. The Cost Department will deal with this form in exactly the same way as with the material requisitions and delivery notes described in this chapter. The whole charges will, of course, be entered up under the heading material " in the summary of cost (Fig 9).

When material is either ordered from an outside supplier or made internally for delivery to the Stores, charges for the material delivered will be made to the Stores and

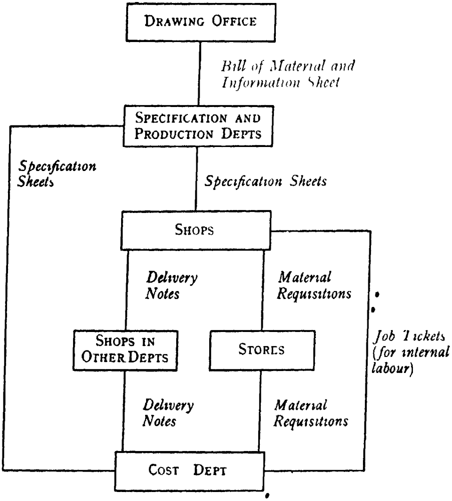


FIG. 10—FORMS USED FOR NOTIFYING THE COST DEPT OF SHOP TRANSACTIONS

entered on a bin card kept for each class of material in the Stores. When a material requisition is received by the Stores the goods will be issued, and the material requisition will be priced against each item by reference to the bin cards Credit will be given to the Stores Account for the value of material issued on all these material requisitions, and corresponding charges will be made to the different departmental Work in Progress Accounts. The individual charges will be entered on the job summaries of cost and specification sheets in the manner already described in this chapter It will, therefore, be seen that the balance of the Stores Account at any time will represent the value of the goods in the Stores at the same date, as an entry in the account is made whenever goods are either received or issued

In Fig 10 a table is given showing the use of the different forms described in this chapter This figure completes the table given in Fig 4 on page 20

CHAPTER V

LABOUR

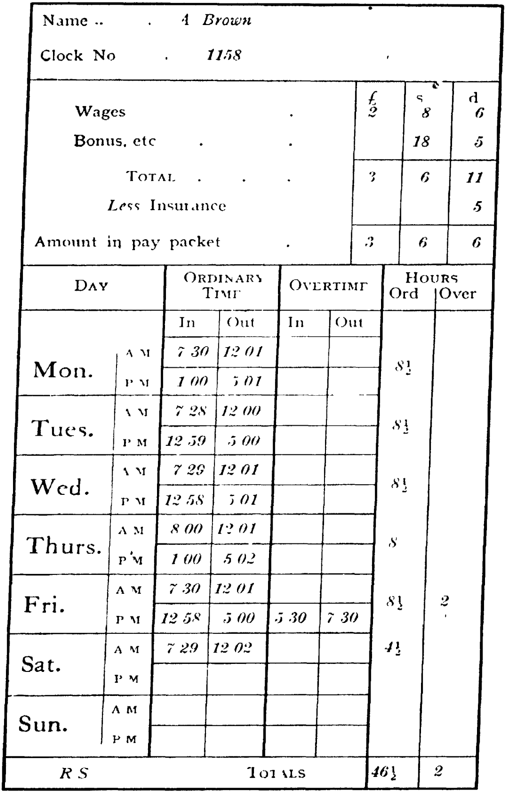
In the previous chapter an outline has been given of the methods adopted for dealing with the charges for material We now come to the methods adopted for dealing with the charges for labour which arise during the conversion of the raw material into the finished article

As far as shop records are concerned there are two principal requirements which have to be met. In the first place a record must be kept of the total time worked by each employee each week. This record is necessary in order to be in a position to calculate day-work wages and to keep a check on absentees and late-comers The record is usually obtained on some form of pay roll clock card such as that illustrated in Fig 11 and described below

The second requirement to be fulfilled is that details must be recorded of what each employee's work consists. All time must be allocated to individual job orders or processes and full details of the work must be given This is partly in order to obtain particulars so that the wages of piece-workers may be computed, and partly in order that the Cost Department may keep an individual cost account of each job or process as described below This record is kept on some form of job ticket such as that illustrated in Figs 13 and 24 and described on page 38

Pay-roll Clock Card

There are several well-known methods of recording how many hours each employee spends at work, but most of the larger engineering firms are adopting one of the several automatic clocks which are now on the market. An illustration of the Gledhill-Brook Clock is given in



Name .. . *A Brown*

Clock No . *1158*

	£	s	d
Wages .	*2*	*8*	*6*
Bonus, etc . .		*18*	*5*
TOTAL . . .	*3*	*6*	*11*
Less Insurance			*5*
Amount in pay packet .	*3*	*6*	*6*

DAY		ORDINARY TIME		OVERTIME		HOURS	
		In	Out	In	Out	Ord	Over
Mon.	A M	*7 30*	*12 01*			*8½*	
	P M	*1 00*	*5 01*				
Tues.	A M	*7 28*	*12 00*			*8½*	
	P M	*12 59*	*5 00*				
Wed.	A M	*7 29*	*12 01*			*8½*	
	P M	*12 58*	*5 01*				
Thurs.	A M	*8 00*	*12 01*			*8*	
	P M	*1 00*	*5 02*				
Fri.	A M	*7 30*	*12 01*			*8½*	*2*
	P M	*12 58*	*5 00*	*5 30*	*7 30*		
Sat.	A M	*7 29*	*12 02*			*4½*	
	P M						
Sun.	A M						
	P M						
R S			TOTALS			*46½*	*2*

FIG. 11.—PAY-ROLL CLOCK CARD.
(The design varies according to the make of the clock)

Fig. 12 When a clock card (Fig. 11) is inserted into the vertical slot in the box at the bottom of the clock (Fig. 12), and the projecting handle is depressed, the time is printed in one of the spaces shown on the clock card. The position of the vertical slot is automatically adjusted so that the printing is shown against the correct day of

FIG 12--GLEDHILL-BROOK CLOCK AND RACKS FOR CARDS

the week. At the end of the week the employee's wages are calculated in conjunction with the job tickets described below, and the amount of the wages is then entered at the top of the clock card together with particulars of any deductions. When the employee is paid the net amount of wages indicated on the clock card he signs the latter at the foot as a receipt. The employee's name and number are most conveniently printed at the top of the clock card by means of some form of addressing machine such as that described in Chapter VII and illustrated in Fig. 20.

For the proper running of any such system it is essential that proper control be exercised by the foremen in the shops, as otherwise it will be found that late or absent employees are sometimes recorded as working full time—the record being made for them by generous but misguided fellow-workers

Job Tickets

The time spent by an employee on each job may either be recorded by means of a clock in the manner just described for the pay-roll clock cards, or the records may be made by hand on some form such as that shown in Fig 13, which illustrates an ordinary job ticket The amount of information to be recorded on the job ticket will depend partly on the system adopted for payment of the employees —whether daywork or piecework or a variation of either of these two main classifications of methods of payment. Other information will be recorded in so far as it is required for the analysis of the cost of a job at its completion

These job tickets are made out daily by or for each employee—a separate job ticket for each order number worked upon At the end of the week the job tickets for each employee are compared with the record on his pay roll clock card and the total hours shown are checked. The wages applicable to each job ticket are then worked out and entered in the columns provided on the ticket (Fig 13), and the total wages transferred to the top of the pay-roll clock card (Fig 11), so that each employee may be able to check his wages when paid.

The preparation of the pay-roll and the payment of wages by the cashier are matters which are outside the scope of this book.

It may perhaps be advisable to indicate briefly the

Dept 3 JOB TICKET Order No *10789*

Name *A Brown—Fitter* Clock No *1158* Machine Group *10*

Date	Time taken		Drawing No	Item No	Quantity	Description of Work
	Hours	Mins				
24 5 23	*2*	*15*	*16542*	*3*	*1*	*Bronze steel boss on pipe*

Inspector's Signature *P I*

Timekeeper's Signature *U N*

	£	s	d
Amount paid		*4*	*5*
Overhead		*3*	*11*

Fig. 13—Job Ticket

difference between the two broad divisions into which methods of calculation of wages may be divided.

In the case of daywork, payment is made at a definite rate per hour, irrespective of the amount of work actually done.

In the case of piecework, payment is made according to the amount of work actually done, the "piecework price" to be paid per unit having been fixed before commencement of the job There are a number of systems of piecework in use and, in addition, a number of bonus systems which attempt to combine the advantages of both the daywork and the piecework systems Details of these systems may be obtained by reference to any textbook on wages systems It may be noted in passing, however, that the use of a piecework system cheapens the product although giving the employees a higher rate of pay

It will be realized that in a large factory very considerable clerical labour is involved in dealing with the individual clock cards and job tickets for each employee, and in the posting of the amounts shown on each job ticket to the respective cost summaries for the purpose of obtaining individual costs for each order number. In order to facilitate the work and cheapen the clerical labour thus involved, a number of mechanical and electrical office appliances are now in use in most progressive firms. This scientifically designed machinery should prove of the greatest interest to the engineer both for its ingenious design and for the place it occupies in the whole system. Some of the most interesting and useful of these machines are used in the systems of mechanical or electrical tabulating which are installed in a number of the larger engineering works in this country. In an engineering works where one of these systems is installed the successful working of the cost system will largely depend upon the scientific organization of this machinery for collecting, sorting and tabulating the many items of information which flow in a continuous stream from the Shops. For this reason a detailed description of one of these systems is given in Chapter VII. At the same time the detailed description of the working of this part of the system should give an insight into the general work of the Cost Department, and form a practical example of considerably more use than a theoretical description of the ideals which every cost accountant would like to realize. It should be noted that in a system such as the one described in Chapter VII the chief difficulties encountered by the Cost Department arise owing to errors in booking in the Shops It is thus very necessary for the Shops staff to have a clear idea of the difficulties encountered in the Cost Department, in order that mistakes may be eliminated and the cost of running the system reduced as far as ever possible

CHAPTER VI

FACTORY OVERHEAD EXPENSES

FACTORY Overhead Expenses is the name used to denote those charges incurred in the manufacturing end of the business which are properly a part of the cost of production, but which cannot conveniently be charged directly to the article or process itself Lists of the main headings under which these expenses may be classified are given on pages 6, 50 and 51 From these lists it will be seen that the term "Factory Overhead" includes all such charges as rent, rates, taxes, motive power, gas, fuel, water, lighting, heating, wages and salaries of foremen, time-keepers, watchmen, etc, depreciation and miscellaneous charges which cannot be directly allocated to job numbers although necessarily incurred in the production of the various jobs on hand at the time We are not here concerned with the details of "Office Oncost Expenses" which are incurred in the Sales and Administrative departments of the Works and over which the engineer usually has no control With the Factory Overhead, however, the engineer is very much involved, and in a live concern he will be required to exert considerable efforts to keep these charges within reasonable limits. It will be apparent that close co-operation is essential between the engineer and the cost accountant with a view to a very detailed analysis being compiled of the charges making up Factory Overhead In one department there may be installed heavy machinery consuming power, taking up a great deal of space, and involving considerable expenditure in wear and tear. These machines, in addition, may use a 50-ton overhead crane, which will still further increase the departmental expenditure In another department the machinery may be light and inexpensive. In yet another, there may be no machinery at all. When plant or machinery is heavy or costly, the expense of its accommodation, the power it consumes, and the cost of supervising and maintaining it may be so great that the average proportion for the factory of these indirect expenses to the direct labour or material charges may be entirely different from the proportions found in the individual departments. The first essential is therefore that the factory overhead must be distributed to the different departments on some equitable basis Some charges will be easy to distribute, as they will only be incurred in definite departments Thus the charges for miscellaneous shop labour (such as sweepers-up, shop clerks and foremen), will be easily apportioned by systematic analysis of the departmental pay-rolls Other charges, such as those for electricity and gas, will be dependent upon exact measurements being made by meter Many charges, however, will only be capable of distribution upon some arbitrary basis In some cases it may be obvious what the arbitrary basis should be This is exampled in the distribution of the charges for timekeepers and for clerks attached to the works cashier, as these charges vary directly as the number of men employed In a few cases the basis of distribution to be adopted will only be decided upon after considerable investigation

The next step after apportioning the different charges to the departments is further to distribute them to the jobs being manufactured This may be done in one of the following two ways—

(1) *Percentage method* The charge for Factory Overhead is made to each job as a percentage addition to the labour (or labour plus material) cost of the job, such percentage being fixed by the ratios of the total departmental charges for labour, material and factory overhead expense Thus if the productive pay-roll of a department were £1,000, and the total factory overhead charges allocated to that

department were £1,500, the Factory Overhead charges might be applied to each job by adding on 150 per cent of the labour booked to the job. Owing to variations of both the pay-roll amount and the actual Factory Overhead charges incurred, it will be unlikely, of course, that the total amount of Factory Overhead "absorbed" on jobs by the percentage additions will be exactly equal to the overhead charges allocated to the departments, and it will be necessary, therefore, to treat any difference as additional profit or loss on the year's working. This percentage method is essentially one of average Under special conditions—such as absence of variety of product—in order to arrive at the amount of Factory Overhead which should be borne by each job it may prove both convenient and accurate, but in the majority of cases this averaging may hide serious losses which are occurring in the manufacture of special articles or which are occasioned by the use of special tools In order to obviate this many firms are now using the "machine-hour rate" method of distributing the Factory Overhead Expenses instead of averaging out the charges by the application of a flat percentage increase on the labour or labour plus material cost

(2) *Machine-hour rate method* In this method every machine-tool is rated for Factory Overhead at so much per hour, and each job is charged with Factory Overhead according to the number of hours spent by the different machine-tools in manufacturing the article Thus, if a finished article had been machined for six hours on machine-tools rated at 3s per hour, and for three hours on machine-tools rated at 5s. per hour, the total Factory Overhead chargeable to the order would be £1 13s. Direct hand labour—such as fitting—would be similarly treated, and the order would be charged so much per hour of hand labour spent on the order.

As this method of charging Factory Overhead is being increasingly employed in engineering works, and as it is a method which should particularly appeal to engineers, it is described below in full detail.

In the first instance all Factory Overhead expenses for a department are distributed amongst the separate machine-tools of the department. An average month's charges will be taken and each overhead expense will be treated separately according to its nature Thus, depreciation charges on the buildings will be distributed according to the proportion of floor-space occupied by each machine-tool, depreciation charges on machinery will be distributed according to the book-value of each machine-tool, and charges for power will be distributed according to the actual power taken by each machine-tool. Full details as to how these charges are distributed are given in the practical example quoted at the end of the present chapter

In order to apply easily the machine-hour rates ultimately decided upon, it is generally found best to make use of the individual job tickets which are usually made up to indicate the amount of work done by each employee on each different job number (*See* Fig 13 and description in Chapter V.) This method involves taking into consideration the number of men employed on each machine-tool when fixing the machine-hour rate Thus, if the overhead charges against a particular large planing machine work out at 16s per hour and two men are required to work the machine, the machine-hour rate will be fixed at 8s per hour, and for every hour's work booked against a job by either of these two men when working on this planing machine an amount of 8s will be added to the total cost in order to cover the Factory Overhead expenses incurred. The next step after determining the charges against each machine-tool is, therefore, to divide the total charges shown against each machine-tool by the number of employees engaged in working each machine. When this has been done it will be found that the different rates thus determined fall naturally into a number of groups for each department, and possibly half a dozen rates may be selected which show only a very small divergence from any of the rates previously calculated for each machine. For practical working all the machine-tools of the department would be given one or other of these six standard rates decided upon, and thereby a large amount of detail work in the cost department is avoided This procedure would not involve any loss of accuracy as the slight approximations would be well within the limits of accuracy of the distribution of some of the overhead charges such as those for heating, transport, and foremen's wages which can only be allocated on an arbitrary basis. As an example of what rates actually occur in engineering work a machine shop might have hourly rates of 2s., 2s. 5d., 3s 7d, and 6s for machine-tools, and 1s. 9d for hand labour, whilst a forge department might have hourly rates of 1s 5d, 2s 9d, 4s 8d and 6s 10d as shown in Fig 18

For purposes of reference each of these rates is given a number, based on some such system of numbering as the following. All group numbers are composed of two figures, the first figure representing the rate per hour and the second figure representing the class of machine-tool Thus, in "Group 47" the figure 4 might indicate a rate of 6s per hour for overhead expenses, and the figure 7 might indicate that the machine-tool concerned was a boring-mill A typical example of group numbers for a machining department is given in Fig 14.

The arrangement of group numbers described permits of several useful results being obtained in addition to the more exact distribution of overhead expenses which results from the installation of the machine-hour rate method of allocation. This method is especially useful where the Hollerith or Powers systems of automatic sorting and tabulating are used (*see* Chapter VII) In these cases it is a very simple matter to prepare a weekly departmental statement of the number of hours worked on each class of machine. From a knowledge of the possible number of hours which could have been worked in each class a good check is obtained as to the correct distribution of machine-tools between departments and as to the efficiency of the working in each department. These weekly statements of machine-hours run will also form an excellent guide whenever the question of obtaining new machine-tools comes up.

By analysis of the costs of completed orders statements of group-hours can be prepared to check that small work is not being unnecessarily machined on heavily-rated tools, thereby causing inefficient working and added expense.

Rate per Hour	Hand Labour	Lathes	Milling Machines	Slotting Machines	Drills	Planer	Grinder	Boring Mills	Screwing Machines	Miscellaneous Machines
2/-	-	11	12	13	14	15	16	17	18	19
2/5	—	21	22	23	24	25	26	27	28	29
3/7	—	31	32	33	34	35	36	37	38	39
6/-	—	41	42	43	44	45	46	47	48	49
1/9	90	—		—			-		—	-

Fig. 14.—Factory Overhead Group Numbers

By means of the various statistics which the cost department is thus enabled to furnish with very little extra trouble or cost, it will probably be found that considerable economies can be introduced into the working of the shops, and this is one of the chief functions of the cost department which will appeal to the engineer.

The whole subject of Factory Overhead Expenses will probably be made much clearer by giving a practical example of how a department is rated on the machine-hour method described above. The example will go a long way to explain the basic facts underlying this important part of cost accountancy, and this will be useful even if the particular system described is not actually met with by the reader.

A forge is not an ideal department in which to apply the machine-hour method of distributing Factory Overhead Expenses, but this department has been selected as an example for the purposes of the present chapter in order to illustrate how special difficulties can be overcome. The forge department discussed below is assumed to employ about 70 men A variety of machine-tools is installed ranging from a 2-ton steam hammer down to a number of small miscellaneous tools such as hack-saws, shears, drills, grindstones, and so on The chief difficulty in such a department is usually found to be that each employee may work on a number of machines and not as in a machining department where, for example, one man will work one particular lathe for weeks together. Where each machine is used by a number of different men the only thing to do is to deal with the machines in groups instead of individually Thus, in the present instance, it may be found that the forge department is capable of rough division into seven groups, the men in each group only working on the machine-tools in that group A statement of these seven main groups for the case under consideration is given below. It is an arbitrary division depending on the particular shop conditions found to be existing.

GROUP 1 Twenty-five smiths and smiths' strikers using between them three 3-cwt steam hammers and three 10-cwt. steam hammers in addition to necessary furnaces, anvils, and so on

GROUP 2 Ten stampers making drop forgings and using between them five electrically-driven drop-hammers of 1-cwt , 7-cwt., 10-cwt , 1-ton and 2-ton capacity, together with necessary furnaces

GROUP 3 A team of four men using a 1-ton steam hammer.

Group 4. A team of five men using a 2-ton steam hammer.

Group 5. One man using two bolt-making machines, two forging machines, and two small saws

Group 6 Fifteen men using miscellaneous machines consisting of two drills, four shears, two circular saws, two hack-saws, two benders and two grindstones.

Group 7 Ten men employed on non-productive work not chargeable direct to jobs, including such occupations as foreman's clerk, coke-wheeler, store-keeper and die-cleaner. The time of these men is a charge against the overhead expenses of the department, and thus forms part of the charges to be divided up between the first six groups detailed above The employees in this department doing productive work chargeable direct to jobs, therefore, total only sixty out of the complete pay-roll of seventy men.

Group		1 Productive Men		2 Area Occupied	
No	Description	No	%	Sq Ft	%
1	Smiths .	25	41 67	12,000	48
2	Stampers	10	16 67	5,000	20
3	1-ton S Hammer	4	6 67	2,000	8
4	2-ton S Hammer	5	8 33	2,500	10
5	Bolt Machines	1	1 66	1,500	6
6	Miscellaneous	15	25 00	2,000	8
	Totals	60	100 00	25,000	100 00

Fig 15—Distribution between Groups of (1) Number of Productive Workers and (2) Area Occupied

The next step to be taken in working out the rates is to measure up the floor area of the forge building occupied by each of the first six groups, and to calculate the percentage area occupied by each group as compared with the total of the six groups. The figures which have been assumed in the present example are given in Fig 15, along with the percentage distribution of the productive workers between the six groups

The different items of overhead expense may now be considered with a view to distribution between the six groups. As a basis of distribution an average month's charges (or the average of six or twelve months' charges) would be taken

It will probably be decided that the expenses listed in Fig 16 can be distributed most fairly on the basis of the number of productive men working in each group (Fig. 15)

Proportion of Expenses of	*Charges for*	*Forge Expenses due to*
Buying Dept	Forge Cranes	Defective work
Mailing Dept	,, Slingers	Lost time
Employment Dept	,, Clerks	Health Insurance
Store-keeping Dept	,, Inspectors	Accident Insur'ce
Transport Dept	,, Foremen	Unemployment Insurance
Time-keeping Dept	,, Store-keeper	Stationery
Cost Dept	,, General labour	Telephones
Research Dept		
Works Cashier's Dept		
Office Heating, etc		

FIG 16--OVERHEAD EXPENSES CHARGEABLE TO FORGE DEPT, WHICH CAN MOST CONVENIENTLY BE DISTRIBUTED ON BASIS OF NUMBER OF PRODUCTIVE MEN EMPLOYED IN EACH GROUP

The total of the charges shown in Fig 16 for an average month is taken to be £500 in the present example. This amount is therefore distributed amongst the groups on the basis of the percentage of the number of productive men in each group as given in Fig 15 This distribution of the £500 is shown in the summary given in Fig. 18.

It is admitted that the correctness of distributing some of the charges given in Fig. 16 according to the number of men in each group is open to argument. Although in some instances it might be fairer to distribute the amounts in proportion to weight output it will probably be found on investigation that the basis of distribution given above is the only practical possibility

Another class of expenses is given in Fig 17, these expenses being most fairly distributed in proportion to the area occupied by each group as given in Fig 15. The total of this class of expense for an average month is taken to be £250 in the present example The distribution of this amount amongst the groups on the basis of the percentage floor-space occupied (Fig 15) is given in the summary shown in Fig 18.

Proportion of Charges for

Depreciation of Buildings
Fire Insurance
Rents, Rates, and Taxes
General Maintenance
Watchmen's Expenses

Forge Expenses for

Lighting
Shop Sweepers

FIG 17 —OVERHEAD EXPENSES CHARGEABLE TO FORGE DEPT, WHICH CAN MOST CONVENIENTLY BE DISTRIBUTED ON BASIS OF FLOOR-SPACE OCCUPIED BY EACH GROUP

A number of other overhead expenses remain to be dealt with These consist of charges which can be more correctly distributed on some other basis than that of floor-space occupied or number of productive men employed. These additional items are shown distributed in Fig 18 on the following bases

Maintenance of Small Tools and Dies (£125). Distributed to the groups on the basis of twelve months' actual charges.

Depreciation of Machine-Tools (£30). Distributed to the groups on the basis of the actual book-value of each tool, i e. purchase price less depreciation to date.

Depreciation of Furnaces (£15). Distributed to the groups in which each furnace is used according to the different book values.

Electrical Power Supply (£200). Distributed according to the power used by each electrically-driven drop-hammer, shears, etc.

Steam Supply (£500). Distributed according to actual amount of steam used by each steam-driven hammer.

Coal, Coke and Oil (£300) Distributed according to the average actual amount used in the furnaces attached to each group of machine-tools

All the overhead expenses chargeable against the forge department have now been distributed between the six groups, and the overhead rate per hour for each productive worker may be calculated by totalling up the expenses shown against each group in Fig 18 and then applying the formula—

Overhead rate per hour for each group $= \dfrac{E}{H \times N}$ where

E = Total overhead expenses for group (Fig 18).
H = Average number of productive hours worked per month by each employee.
N = Number of employees in group.

In Fig. 18 the total charges against each group are shown divided by the respective number of total productive hours per month, thus giving the rates per hour indicated.

It will be seen from Fig. 18 that Group 6 (miscellaneous machines) works out at the lowest rate of 1s 5d. per hour, followed by the smiths at 2s. 9d per hour (Group 1), and the stamps at 4s. 8d. per hour (Group 2). The rates for Groups 3, 4 and 5, however, are very close, and it would probably be expedient to give these three groups a common rate of, say, 6s. 10d. per hour. The final result will then be a division of the forge department into four groups as follows—

Group	19	Smiths and smiths' hammers .	2/9 per hour.
,,	29	Stampers and drop-hammers .	4/8 ,,
,,	39	1-ton, 2-ton steam hammers and bolt-making machines, etc .	6/10 ,,
,,	49	Miscellaneous workers and tools	1/5 ,,

TOTAL AVERAGE MONTHLY CHARGE		DISTRIBUTION OF TOTAL CHARGES BETWEEN GROUPS					
Nature of Charge	Total Amount	Groups					
		1	2	3	4	5	6
		Smiths	Stamps	1-ton S H	2-ton S H	Bolt Mch	Miscel
	£	£	£	£	£	£	£
Charges as per Fig 16	500	208 35	83 35	33 35	41 65	8 30	125·00
,, ,, ,, 17	250	120 00	50 00	20 00	25 00	15 00	20 00
Maintenance of small Tools and Dies	125	6 15	75 80	—	—	18 45	24 60
Depreciation of Machine-tools	30	5 50	10 50	3 00	4 00	2 50	4 50
Depreciation of Furnaces .	15	7 00	5 00	1 25	1 25	50	—
Electrical Power Supply	200	—	168 00	—	—	11 25	20·75
Steam Supply	500	178 00	—	130 00	192 00	—	—
Coal, Coke, and Oil .	300	120 00	39 00	58 00	75 00	8 00	—
A TOTALS	£ 1,920	645 00	431 65	245 40	338 90	64 00	194·85
B Productive Hours (1 month)	11,280	4,700	1,880	752	940	188	2,820
Rate per hour $\left(\frac{B}{A}\right)$.	(*Pence*)	32·94	55 10	78 38	86 53	81·70	16·58
Proposed Rate . .		2,9	4,8	6/10	6/10	6/10	1/5
Proposed Group No		19	29	39	39	39	49

FIG. 18—SUMMARY OF DISTRIBUTION OF OVERHEAD EXPENSES BETWEEN GROUPS AND OF PROPOSED RATES

The method of application of these overhead expense rates would be as follows. A separate job ticket would be prepared for each job done by each employee, as described in Chapter V. This job ticket would quote the job number, the number of hours worked on the job, and the number of the overhead group in which the employee was working. (In order to assist the employees these group numbers would be painted on each machine-tool in a prominent position) When the job tickets eventually reached the cost department, the overhead expense chargeable against each job-number would be calculated by multiplying the number of hours worked by the rate per hour corresponding to the group number shown on the job ticket.

Before actually applying the rates finally decided upon, a test period of one month would be worked in order to prove that the factory overhead charges absorbed under the new method (as shown in Fig 19) were approximately equal to the actual charges incurred by the department. Provided that the monthly charges do not vary to any

1		2	3	4		
No	GROUP Description	Estimated No of Productive Hours Worked (1 month)	Proposed Overhead Expense Rate per Hr	Overhead Expense Absorbed on Jobs (2 3)		
				£	s	d.
19	Smiths	4,700	2/9	646	5	-
29	Stampers	1,880	4/8	438	13	4
39	Steam Hammers	1,880	6/10	642	6	8
49	Miscellaneous	2,820	1/5	199	15	–
Total Overhead Expense absorbed in 1 month				£1,927	–	-
Average actual Overhead Expense for 1 month (as per Fig 18)				£1,920	–	–

FIG. 19.—COMPARISON OF OVERHEAD EXPENSES INCURRED AND AMOUNT ABSORBED ON JOBS FOR ONE MONTH.

large extent, and that the number of productive hours worked in each group have been accurately estimated when determining the rates, close agreement should be found between the actual monthly overhead expenses incurred and the amount absorbed on jobs in any one month

It will be obvious that, despite the various unavoidable approximations that the calculations have incurred, a more accurate cost of any job will be obtained by the application of these varying rates than will be possible by the application of an all-round rate of, say, 150 per cent addition to the labour charges In this particular example a flat rate of this nature would quite possibly have hidden an actual loss being made on all orders coming to the 1-ton and 2-ton steam hammers On the other hand, the cost of other work would have appeared too high, the result being a possible loss of orders Under the method described the costs will be more accurate and the selling price will therefore be more exactly fixed to give the minimum amount of profit decided upon Where competition is severe this may easily make the difference between the gain or the loss of an order, as the overhead expenses are usually an even more important part of the total cost than the direct labour charges

CHAPTER VII

OFFICE MACHINERY

FROM the preceding chapters it will be apparent that a very large clerical staff would be required in any Cost Office which attempted to gather together by hand all the different returns, statistics, and accounts which are demanded. As this would entail very heavy expense; most modern firms have installed office labour-saving devices which greatly increase the quantity of information which can be made available, which increase the speed of producing any required information, and which at the same time considerably reduce the expenses of the department dealing with these figures.

The number of office appliances now on the market is considerable, and will repay the careful study of the cost accountant or engineer interested in office organization. Several of the more important office machines which are likely to be met with are described in the present chapter; but it must be understood that these are only a few out of many, and are only described to indicate how office efficiency may be obtained, to show how the work of the cost office is actually handled, and to illustrate how the modern cost office is increasing in interest and offering more scope for men with organizing abilities.

The principal types of office machines and appliances which are commonly used in connection with costing work are as follows—

1. Adding and calculating machines.
2 Duplicating machines.
3. Addressing machines.
4. Numbering and dating machines

5 Sorting and tabulating machines.
6. Time recorders.[1]

A description of one type of time recorder has been given already in Chapter V (page 37) and it is illustrated in Fig 12. In the same chapter mention was also made of the use of addressing machines for the printing of employees' names and numbers at the top of pay-roll clock cards, on pay-roll lists, and on pay packets, etc In these machines metallic stencils are embossed with the names, numbers or other required information, and are kept filed in order. For printing, these stencils are used in connection with an addressing machine such as the Elliott Electric Addressing Machine illustrated in Fig. 20 This machine is driven by means of a $\frac{1}{6}$th h p motor, and is controlled by a foot lever, the depressing of which sets the machine in motion. As long as the lever is held down the machine goes on running ; by raising the foot the machine can be stopped at every impression if required When running the machine makes 3,000 to 3,600 impressions per hour The stencils waiting to pass through the machine are shown in the holder at the top right-hand side of Fig. 20

Of adding, calculating, duplicating, numbering and dating machines there is a great variety of makes upon the market In a modern office they are almost indispensable, as they save a large amount of uninteresting clerical labour in addition to their advantages of both speed and neatness. In general the manner of working these machines is easy to understand, although, of course, speed of manipulation is attained only by practice. For a detailed description the reader is referred to the book mentioned in the foot note below.

Where a system of automatic sorting and tabulating is in use, the apparatus used is much more intricate and the influence of the system is much more apparent in the general organization of the works As a number of the largest manufacturing engineers in this country are now using one of these systems for automatically dealing with large quantities of information, a description is given here of the Hollerith Electrical System Another system which is extensively used is that of the Powers Mechanical System.

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[1] For a clear and complete description of all these and many other types of office machines, see *Office Machines, Appliances, and Methods,* by W Desborough, F C I (Published by Sir Isaac Pitman & Sons, Ltd)

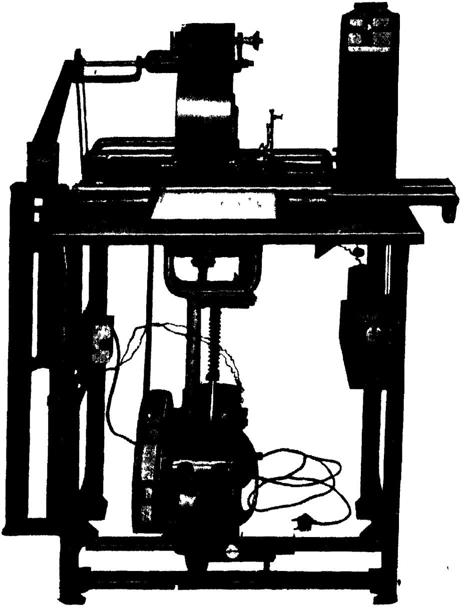


FIG 20 —ELLIOTT ELECTRIC ADDRESSING MACHINE

Although these machines are of entirely different principle and design, the results obtained are approximately the same. Each system has its own special advantages, and the choice of which system should be used depends entirely on local conditions. Space only permits of the description of one of these systems, but, as will be shown at the close of the present chapter, wherever such a system is installed it is of the greatest advantage for both the engineer and the cost accountant that a clear conception should be held in the shops of the uses, difficulties and possibilities of the machines.

In the Hollerith system all information is transferred from the original written document to a special card by means of punching holes in the card. The position of the hole determines what it is intended to represent. A typical punched card is illustrated in Fig. 21 on a black background and described below.

The card used is of thin pasteboard, measures 3¼ in. by 7⅜ in. and provides space for forty-five vertical columns. It will be observed that two or more vertical rows of figures can be used for one group or "field" to represent a number greater than 9. Thus for a sum of money under £10 in value five columns will be required, one for the pounds, two for the shillings, and two for the pence.

Certain information can only be transferred to the Hollerith cards by the use of a system of codes. Thus, suppose it is required to record the name of the employee, every worker must be given a number, and then it will become possible to punch the numbers on the cards to represent the names of the employees.

The card illustrated in Fig. 21 is arranged to record the cost of labour and overhead expenses. This card is the one which would be used in conjunction with the job ticket shown in Fig. 13 on page 39. It will be understood easily by following the card through item by item in conjunction with this description.

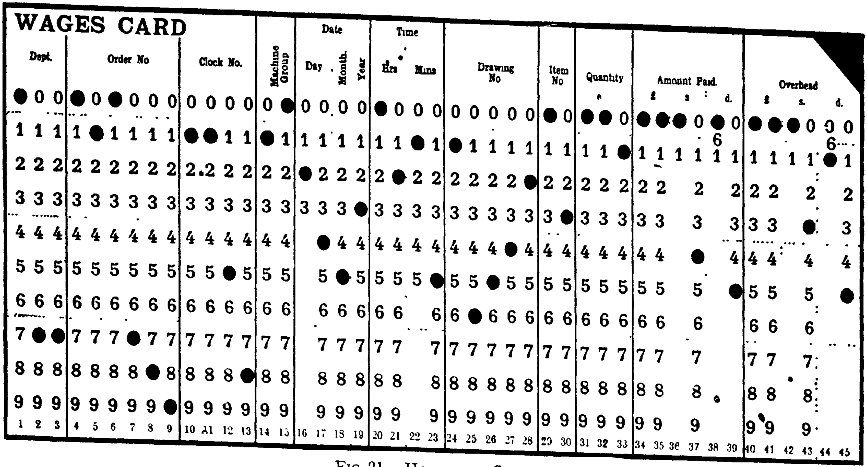


FIG 21 —HOLLERITH CARD

The first three holes are for the figures indicating the departmental number (077), the next six figures being for the order number (010789). The clock No. is then given as 1158, and the machine group as 10 This is followed by the date (24/5/3) and the time taken (02 hours, 15 mins) The drawing and item numbers are given as 16542 and 03 respectively. The remainder of the card shows that the quantity is 1, the amount paid is 4s 5d , and the overhead expenses amount to 3s. 11d. (the 11d. being punched as 6d. + 5d).

The holes are punched in the cards by hand by means of a small machine with a keyboard resembling that of a miniature typewriter.

When the Hollerith cards have been punched and verified they are ready for use with the sorting and tabulating machines. The written records from which they are copied are filed away in case reference is required to the original written documents ; otherwise all particulars and statistics are obtained from the punched Hollerith card copies.

The electrical sorting machine is illustrated in Fig 22. A bunch of punched cards is placed at the top of the sorter (A) Directly the motor is started by means of a press-button (B), the cards are dealt with in turn and sorted automatically into numerical order at the rate of 15,000 cards per hour. The cards to be sorted are automatically brought down one at a time facing an electrical brush (E) which controls the sorting mechanism Wherever there is a surface of card it acts as an insulator, but where a hole has been punched to represent a number, the current passes through and opens a channel (D) leading to the correspondingly numbered compartment (C).

The tabulating machine completes the equipment of the Hollerith system. This machine is illustrated in Fig. 23 and is used for adding together the hours, money, weights, and similar particulars which are punched on

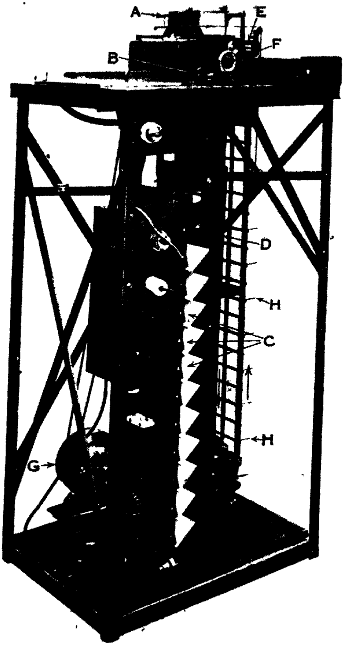


FIG 22—HOLLERITH ELECTRICAL SORTING MACHINE.

the individual cards and indicating these totals under the headings of job number, drawing number, or other classification.

A pack of sorted Hollerith cards is placed at A (*see* Fig. 23), and each card is fed down separately into the machine by means of the motor situated at B.

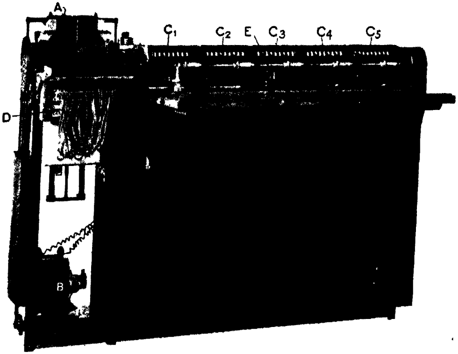


FIG. 23.—HOLLERITH ELECTRICAL TABULATING MACHINE

As each punched card is brought into position the whole face of the card is swept by forty-five brushes which make electrical contact through any holes that have been punched and which operate a number of counters arranged like a complicated cyclometer. A similar arrangement to that of the sorting machine ensures that each counter is only actuated by the current passing through a correspondingly numbered hole in the Hollerith card.

The counters (C) are arranged in five sets and permit of five different totals being obtained at the same time. Each counter adds on the figure punched on the card, and the counters are connected together so as to carry forward the totals from one column to the next in the same way as is done in an ordinary adding machine. The first set of counters (C_1) is usually used as an indicator for registering the title of the account (such as job number). It registers the first card of the batch and then remains stationary whilst the other counters are totalling. When the totals have been obtained it is released to zero along with the other counters that are not running for progressive totals. One set of counters may be used for intermediate totals and another set of counters for an accumulative total For example, the value of each job may be given on one set of counters and the total value of all the jobs may be given on another set of counters.

The tabulating machine works at the rate of 9,000 cards per hour, adding up to as many as four different totals at the same time.

The chief advantages of a system such as the one described above are claimed to be—

(1) The greatly increased speed with which returns and statistics can be compiled

(2) The increased amount of statistical information which is readily obtainable by rapidly re-sorting the punched cards into different classifications

(3) The elimination of hand-sorting and tabulation from the work of the clerical staff with consequent increased attention to critical and constructive work

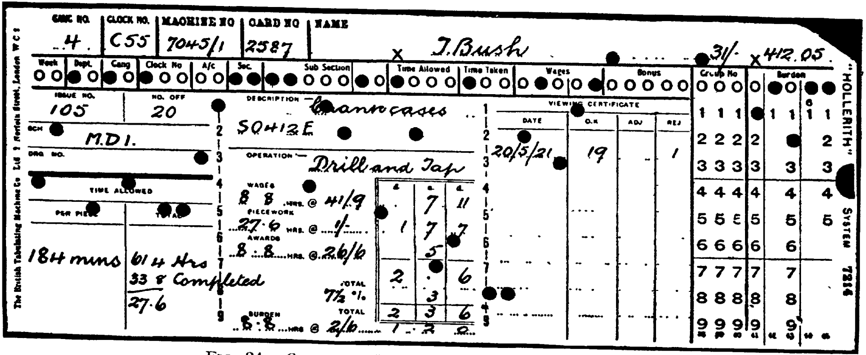
(4) A considerable saving of Factory Overhead charges (as regards the item of office expenses) for an equivalent amount of statistical information produced.

These advantages are of considerable value if only they can be actually obtained in practice. Whether the system is thoroughly efficient or not depends very largely on the correctness and completeness of the information emanating from the shops. If incorrect numbers are quoted and sent to the Cost Department, a great deal of the machine efficiency will be lost owing to the time occupied in tracing queries from the punched card back to the original record and thence to the Shops. Owing to the necessity of turning up original records in particular cases, the advantage of machine-sorting is lost, for in this case the original records have to be sorted by hand in addition to the machine sorting of the punched cards These and other difficulties can be overcome, however, if the Shops will take an interest and appreciate the value of the returns they make. With the object of checking and eliminating more easily the errors of the Shops, a combination of the job ticket and Hollerith card may be used The Hollerith card with the job ticket printed on it may be issued to the Shops for insertion of their written record, the same card then being punched for use with the sorting and tabulating machines

Such a job ticket is illustrated in Fig 24, the only difficulty in its use being the necessity of careful handling so that the edges shall not get damaged in such a degree as to interfere with the working of the sorting and tabulating machines.

The use of such a card, besides making the working more easy, will reduce office expenses by reducing the number and variety of forms used with a consequent saving of paper, printing, storage, and handling expenses

It will be seen from Fig 24 that the employee enters the particulars along the top edge and left side of the card, whilst the Wages Office extend the wages in the centre of the card The headings for the columns of punched holes are shown in Fig 24 just above the line of O's, the first two holes from the left indicating the week (42), the next two holes giving the department (5), followed by two holes for gang No (4), three holes for clock No. (55), and so on



"HOLLERITH" SYSTEM 7214

GANG NO. ..4.

CLOCK NO. C55

MACHINE NO 7045/1

CARD NO 2587

NAME x J. Bush

31/- x 412.05.

ISSUE NO. 105

NO. OFF 20

SCH M.D.I.

DRG. NO.

DESCRIPTION — Crankcases

SQ412E

OPERATION — Drill and Tap

TIME ALLOWED

PER PIECE 184 mins

TOTAL 61 4 Hrs

33 8 Completed

27.6

	£	s.	d.
WAGES 8 8 HRS. @ 41/9		7	11
PIECEWORK 27.6 HRS. @ 1/-	1	7	7
AWARDS 8 8 HRS. @ 26/6		5	
TOTAL	2		6
7½ %		3	
TOTAL	2	3	6
BURDEN 8 8 HRS @ 2/6	1	2	0

VIEWING CERTIFICATE

DATE	O.K.	ADJ	REJ
20/5/21	19		1

The British Tabulating Machine Co Ltd 1 Norfolk Street, London W C 2

FIG 24 —COMBINED JOB TICKET AND HOLLERITH CARD

CHAPTER VIII

COST STATEMENTS AND RETURNS

In previous chapters a description has been given of the work of the Cost Department with relation to the returns and information which the Cost Department requires from other departments The expense of obtaining and analysing all this information in a large Works is considerable, and the Management would always require some definite results in return for the outlay of office equipment, and the expense of clerical labour, stationery, heating, lighting, and other attendant charges This brings us to the consideration of the other side of the question. What can the Cost Department give out in the way of summarized or detailed information as a result of all the details of work which are supplied by the Shops, Stores, Buying Department, and other sections of the Works? The chief object of the Cost Department is to give out information as to how the manufacturing has been done The information which can be given out may be summarized under the headings on page 68

The Cost Department should collect and tabulate facts with a view to assisting the Management to—

(1) Find out what processes of manufacture are costly or inefficient

(2) Appreciate in what ways overhead expenses may be reduced

(3) Discover new and better methods of manufacture.

(4) Know where time is being lost and material wasted and thus find out how production may be speeded up.

(5) Keep the factory full of work by means of intelligent tendering with a sound margin of profit.

These differing objects are achieved by means of a series of regular returns and reports which are submitted by the

Cost Department to the Management, the departmental chiefs, the foremen, and any other interested parties. These returns and reports will be both numerous and varied, but they should all have several characteristics in common. They must contain information which can be made use of and which is wanted (or which *ought* to be wanted), wherever possible they should be in tabulated form, and they must invariably be perfectly clear and concise and present information in such a way that it can be readily assimilated Graphical representation should be freely used and, in general, the information should be given in the way which will most readily appeal to the recipients. If the engineer is not receiving sufficient information or if the information he receives is not clearly put together, he should press his claims until they receive the attention that they deserve For the engineer spends a good deal of his time in supplying the Cost Department with the details of the work done in the Shops, and he is therefore entitled to get proper returns in exchange. The Cost Department exists to supply information, and, if it fails in this, it forms an unjustified expense

Some of the more important statements and returns which may be made by the Cost Department are tabulated below and described in the following pages. It will be observed that some of the returns are of a routine nature for such purposes as to enable wages to be paid or the monthly balance sheet to be compiled, whilst others are compiled for the purpose of control and for examination of past work with a view to eliminate waste and to plan future work in the most economical way Some of the statements, of course, fulfil both objects

A. Returns relating to shop labour

(1) Pay-roll.
(2) Pay-roll statistics.
(3) Distribution of time between machine groups.

(4) Excessive piece-work bonus earnings.
(5) Income Tax and Board of Trade Returns

B. Returns relating to material

(1) Departmental receipts and issues
(2) Defective material, workmanship and design
(3) Stock to be depreciated in value or scrapped

C. Returns relating to factory overhead expense

(1) Analysed statements of departmental expenses
(2) Factory Overhead Expense statistics

D. Returns relating to costs of jobs and stock parts

(1) Summary of actual costs of jobs and stock parts
(2) Analysis of costs of jobs and stock parts
(3) Statements of excess costs
(4) Price data

E. Miscellaneous returns

(1) General departmental statistics
(2) Graphical representation

F. Foundry statements

A. RETURNS RELATING TO SHOP LABOUR

(1) The pay-roll is a straightforward statement of the amount of wages due to each employee The net amount is shown opposite each name together with particulars of any deductions from the gross amount for health and unemployment insurance, payments in advance, club contributions, etc.

The most convenient way of compiling the pay-roll in a large firm is to print the names by means of an addressing machine (Fig. 20), and add particulars of the wages by means of an electrically-driven Burroughs Pay-roll Adding Machine.

The pay-roll is used by the cashier for making up the wages of each employee. The details shown thereon form the basis of the other three returns described in this section and the totals are required for posting to the Work in Progress and other accounts (p 9).

(2) Useful information may be given to the management and heads of departments by means of weekly departmental returns of pay-roll statistics. This return would tabulate facts such as the following—

No of Employees—Male
,, ,, —Female
,, ,, on Overtime
,, ,, ,, Nightwork

Hours worked—Total
,, ,, —Overtime
,, ,, —Nightwork
,, ,, - Paid Daywork
,, ,, — ,, Piecework

Total pay-roll value
Total day-work earnings
Per cent of day-work earnings to total pay-roll
Total piece-work earnings
Per cent of piece-work earnings to total pay-roll

Value of piece-work bonus earned
Per cent of bonus to piece-work time earnings
Average rate of pay per hour—males
Average rate of pay per hour—females

(3) In addition to the above a statement should be given of the hours and amount against each group of machines if the department uses the machine-hour method of distributing factory overhead expense as explained in Chapter VI These figures, together with an analysis of hours and amount into "Direct Labour for Customers' Orders," and "Indirect Labour charged to Factory Overhead Expenses," may readily be obtained by use of automatic sorting apparatus such as that described in Chapter VII. An indication of the uses to which this return may be put is given on pages 46 and 47

Both these last two returns should be so arranged as to show the comparison between present figures and those of former months and of the previous years' averages This arrangement will greatly increase the value of the figures.

(4) Rate-fixers should be supplied with a weekly list showing all excessive bonuses which have been earned by piece-workers This will draw attention to those piece-work rates which require revision when opportunity occurs and will assist in the setting up of new rates

(5) The Board of Trade require a number of returns to be made, but these will not be discussed here, although mention should perhaps be made of that requiring a statement of the total wages paid to each employee each quarter, the statement being for the use of the Income Tax authorities

B RETURNS RELATING TO MATERIAL.

(1) Departmental statements should be prepared every month to show the total receipts from and issues to every other department during the month Receipts will include charges for raw material drawn from the central stores and for finished or part-finished goods obtained from the Buying Department or delivered by other manufacturing departments Issues will include credits received from Stores or Warehouse for parts completed and shipped as well as charges for incomplete work sent to other manufacturing departments during the month For purposes of criticism this return should show the comparison of previous months' figures and of the last year's averages After deduction from the receipts of allowances for scrap and defective material and of the value of material charged to Factory Overhead expenses, the totals are used for posting to the Work in Progress Statement (p 9) For those whose business it is to keep the Work in Progress balance as low as possible, this statement of where these charges come from will be found most useful Thus an increase in the balance for a machining department may possibly be traced readily to the fact that deliveries of castings from the foundry have increased considerably over the average and in advance of requirements The

form of this return should be as simple as possible, such as that given in Fig. 25.

RECEIPTS by
ISSUES by } TURBINE DEPT YEAR 1923

From or To	Last Year's Average		January		February		March		
	Recei'ts	Issues	Recei'ts	Issues	Recei'ts	Issues	Recei'ts	Issues	
	£	£	£	£	£	£	£	£	
Iron Foundry	7,180	300	9,410	381	8,761	506	11,610	741	
Brass Foundry	500	49	580	101	570	45	701	88	
Forge	999	3	910	7	1,010	10	1,060	11	etc
Pattern Shop	1,366	7	1,410	3	1,300	15	1,875	15	
Joiners' Shop	40	—	36	—	21	—	45	2	
etc	etc	etc							etc

FIG 25 —DEPARTMENTAL STATEMENT OF RECEIPTS AND ISSUES

(2) A check on waste can be made by means of monthly returns showing the losses due to defective workmanship, defective design, and defective material These returns are compiled on a departmental basis from the credit notes issued by the Shops (p 31). The returns should indicate the amount of defective work for which each shop is responsible, and should be accompanied by a detailed list of the larger charges showing how they were individually incurred. The totals of these returns will be required for entry on the departmental statements of receipts and issues as described above.

(3) Any obsolete parts which require scrapping or depreciating in value must be reported in order that they may be priced and their book-value reduced, and the departmental Work in Progress account relieved accordingly.

C. RETURNS RELATING TO FACTORY OVERHEAD EXPENSE

(1) Factory Overhead Expenses require more careful control than any other class of expenditure if they are not to exceed their proper proportion of the total outlay. The most satisfactory method of control is to institute a comprehensive series of Factory Overhead Expense numbers, and to ensure that all indirect labour and material charges are booked to these numbers combined with the numbers of the departments for which the work is required. Thus for Department No 121 charges for sweeping-up the shops and for foremen's wages might be booked to Nos 14/121 and 78/121 respectively If some such system as this is adopted the Cost Department will be able to present a very useful monthly analysis of the overhead expenses. This analysis will give the total monthly charges against each heading of expense for each department, together with a comparative statement of what each expense amounted to in the preceding months.

The value of this statement will be enhanced if the expenses are further sub-divided into three groups—

(*a*) Those expenses which are controlled by the foremen, such as shop sweepers, lost material, foremen's clerks, waiting time, and maintenance of tools

(*b*) Those expenses which are controlled by the heads of departments, such as power charges, health insurance, and specification clerks

(*c*) Those expenses which are controlled by the management such as rent, estimating, watchmen, research, cashier, and transport.

These returns should be accompanied by an explanatory letter emphasizing any increased expenditure under any heading. If handled properly these returns will be the means of a considerable reduction in Factory Overhead expenditure.

(2) In addition to the above a departmental summary of Factory Overhead Expense should be given to show

the total actual factory expenses and the percentage that this is of the total productive labour charges Further items should be given to show the estimated expense (i e the amount absorbed on orders, *see* p 54) and the percentage that this bears to the total productive labour charges. The final item of the return will show the adjustment (surplus or deficit) between the actual overhead expenses incurred and the estimated overhead expenses absorbed on jobs

D RETURNS RELATING TO COSTS OF JOBS AND STOCK PARTS

(1) All charges against each individual job are usually collected on some form of summary of costs such as that illustrated in Fig 9 on p 30 When each job is shipped the summary of costs will show the total cost analysed into labour, overhead, material and drawing office charges. The cost of parts made for stock can be treated in exactly the same way The costs of all goods completed during each month should be tabulated and compared with the estimates, one copy of the statement being for the use of the Management, and one copy for the use of the Estimators. By noting the variation between actual and estimated costs considerable help should be obtained for the framing of future estimates Any costs which show a wide divergence from the estimate should be analysed as described below. Where standard articles are being made, the costs should be tabulated according to type in order to show up any irregularities

(2) All new types of work and all jobs where the estimate is not close to the actual cost should have the costs analysed in detail. This will be of assistance to the Shops in eliminating waste and wasteful methods, and will enable the estimators to adjust their estimates to present conditions.

The degree to which the analysis should be carried will vary with different jobs Thus for apparatus involving

a big labour cost the most suitable analysis might be on the lines of that shown in Fig 26 In this figure is shown a small portion of the analysis of the cost of a steam turbine If the second portion of the analysis be examined first it will be seen that the turbine has been divided up into a number of sections—(1) Bedplate and details, (2) Spindle and details, etc The total cost is given of each of these sections, figures being given of the charges for material, fitting labour and overhead, machining labour and overhead, and hours spent on machining and fitting (divided into day-work and piece-work) Detailed particulars are given in the first portion of the analysis of the estimate and of the description and weight of materials used. In this part of the analysis each section is analysed into the same details as those quoted above At the foot of the analysis a comparison is made between the actual and estimated cost under the headings of " material," " labour," " overhead " and " other charges "

In some classes of work an analysis such as the above will not be sufficient, and in these cases it will be necessary to analyse the labour and overhead charges into operation costs as illustrated in Fig 27, which shows a portion of the analysis of the cost of a meter giving all available particulars

(3) Closely allied with the subject of analysed costs are statements of excess costs which have been incurred due to increased cost of material or labour For the use of estimators these statements may take the form of bringing analysed costs of past work to an up-to-date figure by means of making allowances for the known variations in the prices of materials and the rates of pay and of overhead charges. Where excess costs that have been incurred can be recovered from the customer under the terms of the contract, the Financial Department will require a statement showing the value of such excess costs and the manner in which they have been incurred

Part No	MATERIAL	Op'n No	OPERATION	Time (Mins)	Material			Labour			Overhead			Total Cost		
					£	s	d	£	s	d	£	s	d	£	s	d
4603	*200 Brass Terminals*					10	8								10	8
		37	Cutting	36					–	3½		–	9		1	–½
		40	Drilling	198					1	6½		4	1½		5	8
		91	Tapping	65					–	7¼		1	4¼		1	11½
		38	Coking	48					–	7		1	–		1	7
		36	Counter bore	56					–	5¼		1	2		1	7¼
		39	Lacquering	28					–	4½		–	7		–	11½
						10	8		3	10		8	11¾	1	3	5¾
6626	*100 Wheels*—															
7383	100 Blanks	89	Stamping	51		4	10		1	7		1	10		8	3
6349	100 Hubs	37	Cutting	32		–	2		–	5		–	8¾		1	3¾
		96	Turning	13					–	2		–	3¼		–	5¼
		40	Drilling	55					–	7		1	1¾		1	8¾
		23	Hubbing	19					–	3		–	4¾		–	7¾
		72	Reamering	10					–	1½		–	2½		–	4
		49	Cutting Teeth	45					1	2		–	11		2	1
		39	Lacquering	4					–	1½		–	1		–	2½
						5	–		4	5		5	7		15	–
	etc		etc					etc							etc	

FIG 27 —PORTION OF ANALYSIS OF COST OF METER (*100 Meters analysed to Operations*)

For special purposes still other types of analysis will probably be required, and these should easily be produced if the costing system is in good working order and sufficient staff is allotted for the work It cannot be too strongly emphasized, however, that the value of this analytical work is entirely dependent on the engineers and shops foremen who alone can ensure correct booking of time worked and the entering of full particulars of all material drawn from stores If the shop records are inaccurate the results produced by the Cost Department are bound to suffer

(4) The Cost Department usually forms a convenient centre for the collection and distribution of various kinds of price data Particulars may be tabulated of the variation in price of the different kinds of raw materials and of fittings that are bought, and comparison may be made of the prices of outside suppliers and the costs of internal manufactures in conjunction with a comparison of home and foreign prices. This information will be of the greatest use to estimators, the Buying Department and the Management.

E MISCELLANEOUS RETURNS

(1) From the point of view of the head of a department or of the management it is desirable that the main items in the foregoing returns which indicate the degree of efficiency of a department should be collected together into one combined statement. The statement would be arranged to show the totals for each month of the year against each item so that comparison of the results may easily be made. As an illustration, the following might represent the items which would be included in the statement for a department manufacturing electrical transformers.

(1) Output for month in tons
(2) Total hours worked.

(3) Wages paid		(*a*) Total
		(*b*) Direct
(4) Overhead expense		(*a*) Actual—amount incurred
		(*b*) Estimated-amount absorbed
		(*c*) Loss or gain $(a \sim b)$
(5) Number of employees		(*a*) Total
		(*b*) Men
		(*c*) Women
(6) Average wages	Pence per hour	(*a*) Men
		(*b*) Women
(7) Overtime		Per cent to total hours
(8) Piece-work		(*a*) Per cent to total pay-roll
		(*b*) ,, bonus earned
(9) Output per 1,000 hours		Tons
(10) Cost		Per ton
(11) Cost of completed jobs		(*a*) Actual
		(*b*) Estimated
		(*c*) Surplus $(b - a)$
		(*d*) Per cent of surplus to estimated cost
		(*e*) Deficit $(a - b)$
		(*f*) Per cent of deficit to estimated cost
(12) Tenders		(*a*) Total number and value
		(*b*) Per cent rejected owing to high prices
		(*c*) Per cent rejected owing to late delivery date
(13) Value of Work-in-Progress balance		

Comparative figures on the lines indicated above will enable those responsible to keep a very close check on the work of a department, and will ensure, *inter alia*, that tenders are not being lost owing to estimates being in excess of actual costs

(2) A considerable proportion of the information contained in the above returns is capable of graphical representation, and, where this method is possible, it will usually be found that such treatment lends considerably to the clarity of the statements, and will emphasize many points which would otherwise be missed.

F. FOUNDRY WORK

(1) Foundry work is of especial interest to the engineer as he is largely dependent on the products of the foundry

for his raw material. In many ways foundry costs require special treatment owing to the unique nature of the work Usually the method adopted is a combination of job and process costs (*see* p. 9) The cost may be apportioned to each job by operation Thus the cost of a casting may be shown as follows—

(*a*) Cost of metal at cupula spout (Material, labour and overhead expense)
(*b*) Moulding. (Labour and overhead expense)
(*c*) Core-making (Labour and overhead expense)
(*d*) Cleaning and Fettling (Labour and overhead expense)

The overhead charges may be distributed on a basis of a percentage on the direct labour charges, a machine-hour rate method, a rate-per-lb method, or by a combination of these methods Particular care is required in the treatment of the cost of defective castings and of pouring losses Foundry work may be classified into a number of groups, and castings are then charged out at a fixed rate per lb according to the classification of the particular castings being charged The difference between the total of these estimated charges for a month's work and that of the actual expenses incurred represents profit or loss for the month

(2) In line with the procedure adopted for other departments, a monthly statement of general foundry statistics may be prepared by the Cost Department Comparative figures would be given for such items as the following—

(1) Cost in pence per lb	(*a*) Total
	(*b*) Material
	(*c*) Labour
	(*d*) Overhead
(2) Delivery price in pence per lb	
(3) Profit or loss for month	
(4) Output in lbs	(*a*) Total for month
	(*b*) Average per man-hour
(5) Overtime	Per cent to total hours
(6) Average hourly pay	
(7) Wastage, per cent	

INPUT.

DETAILS				Total Cost			Cost d /lb of Output
				£	s	d	d
1 Work in hand at end of May — Brought forward							
Castings in stock				3,412	1	2	
Work on unfinished Cores							
Labour	£398	2	6				
Overhead Expense	597	3	9				
				995	6	3	
Work on unfinished Moulds							
Labour	406	3	4				
Overhead Expense	609	5	–				
				1,015	8	4	
2 Adjustment for differences in unfinished work at end of May and June—							
Cores Labour	100						·026
Overhead Expenses	150						·039
Moulds Labour	54	16	8				014
Overhead Expenses	82	5					021
3. Labour Charges for June—							
Core-making	631	3	4				163
Moulding	3,006	7	8				777
Fettling	542	13	6				·140
				4,180	4	6	
4 Actual Factory Overhead Charges				5,206	17	3	1 347
5. Material Charges—							
Pig-iron	2,400	1	3				
Scrap	431	2	6				
Coke	613	4	6				
Sand	300	10	–				
Plumbago	45	5	–				
Oil	70	3	4				
Miscellaneous	210	3	6				
				4,070	10	1	1 054
6 Balance (Profit for June)				1,274	1	7	
TOTALS				£20,154	9	2	3 581

WEIGHT OF OUTPUT	LBS
Castings shipped in June	899,001
Castings in Stock at end of June	224,112
Total	1,123,113
Less Castings in Stock at end of May	196,098
Net Weight produced in June	927,015

FIG 28.—IRON FOUNDRY STATEMENT

OUTPUT.

	Details				Value £	s.	d
1	Castings shipped in June				14,366	16	6
2	Work in hand at end of June—Carried forward						
	Castings in Stock				3,922	12	2
	Work on unfinished Cores						
	Labour	£298	2	6			
	Overhead Expense	447	3	9	745	6	3
	Work on unfinished Moulds						
	Labour	351	6	8			
	Overhead Expense	527	–	-	878	6	8
3	Foundry Equipment				241	7	7
					£ 20,154	9	2

AVERAGE COST (PENCE PER LB)

	May	June
Net Weight produced	863,144 lbs	927,015 lbs
	d	*d*
Labour	1·203	1·120
Overhead Expense	1·521	1·407
Material	1·044	1·054
Total Cost per lb (*d*)	3·768	3·581

FOR 30TH JUNE, 1924.

In addition to the above statistics a monthly statement should be prepared showing the results of the month's work. Such a statement is illustrated in Fig 28.

On the left-hand side of the statement particulars are given of the input of material, labour and overhead expense, together with the unit cost per lb. of castings produced for each item A statement of the weight of castings produced is given at the foot of the form, and this total divided into the figures of the first or second columns will give the figures shown in the third column

As the weights represented by the items in section 1 are not included in the statement of net weight produced shown at the bottom of the form, the unit costs per lb. of output are not shown in the third column for this section.

Section 2 represents an adjustment to the cost per lb of output to allow for the difference in the amounts of unfinished work at the end of May and June This adjustment is necessary as obviously output will have been obtained at the expense of work in hand The adjustment does not, however, affect the total expenditure for the month The remaining sections under input are self-explanatory

On the right-hand side of the statement are given particulars of the output for the month, separate sections being given for castings shipped, work in hand at the end of the month, and foundry equipment At the bottom of the page a comparative statement is given for the cost per lb of output for the month under consideration, together with that for the preceding month.

BIBLIOGRAPHY

THERE exist a large number of books on the subject of Costing, amongst which the following standard text-books may be of use to those who wish to study further the science of cost accountancy. It should be noted that there are many other books of merit that have not been included.

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Cost Accounts for the Metal Industry. H. E. PARKES, M.Com., A.C.W.A. Demy 8vo, 156 pp.

Cost Accounts in Principle and Practice. A. CLIFFORD RIDGWAY, F.C.A. Demy 8vo, 120 pp.

Costing and Price Fixing. J. M. SCOTT-MAXWELL, B.Sc. Demy 8vo, 210 pp.

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Factory Accounts. E. GARCKE, F.C.W.A., and J. M. FELLS, F.C.W.A. 8vo, 290 pp.

Factory Administration and Cost Accounts. E. T. ELBOURNE. 8vo, 811 pp.

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